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Multiple Air Toxics Exposure Study Working Paper Number 3. Urban Air Toxics Exposure Model: Development and Application

South Coast Air Quality Management District
El Monte, CA

Prepared for

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16. ABSTRACT

The South Coast Air Quality Management District of California has completed a Multiple Air Toxics Exposure Study (MATES) which examines the additive risk from a number of air toxics on an urban area. The ~~This~~ project, though partically funded by EPA, is an example of how a State or local agency may approach assessing their local air toxics risks as is encouraged by EPA's Urban Air Toxics Program which results from EPA's Air Toxic Strategy. The ~~This~~ report is a summary of the methods used by the ~~this~~ California agency. Though not intended as an endorsement of the entire contents of the report, EPA is reproducing their report (working paper number 3) to benefit and encourage other agencies which may be contemplating such an assessment.

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WORKING PAPER NO. 3
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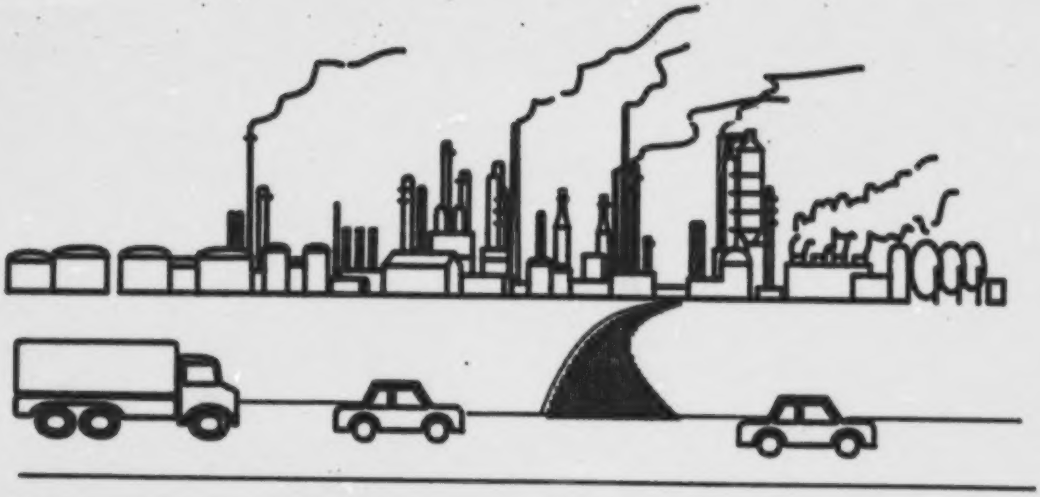

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MULTIPLE AIR TOXICS EXPOSURE STUDY
WORKING PAPER NO. 3

URBAN AIR TOXICS EXPOSURE MODEL: DEVELOPMENT AND APPLICATION

Prepared by

South Coast Air Quality Management District
Systems Applications, Incorporated

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INTRODUCTION/PURPOSE

The Environmental Protection Agency's Administrator, Lee Thomas, released "A Strategy to Reduce Risks to Public Health from Air Toxics" on June 11, 1985. This has later become known as EPA's National Air Toxics Strategy." One important leg of this strategy focuses on the multi-pollutant/multi-source impacts which have been characterized as urban air toxics. EPA has been working to implement the strategy in several ways.

Efforts to date, in the urban air toxics area have been to:

- °Assess the problem from a national perspective to develop better evidence and documentation of it's magnitude and character.
- °Promote State and local urban air assessment activities by State and local agencies.
- °Develop guidance and analytical tools needed for States and local agencies to assess the problems.
- °Encourage State and local agencies to evaluate options for mitigation of problem areas.
- °Encourage State and local agencies to mitigate these situations where warranted.

Urban air toxics assessment efforts have begun to provide returns in several areas, especially where State and local agencies were already interested and involved in examining the problem. One such area where advanced concern and activities have occured is the South Coast Air Quality Management District of California (Los Angeles area). The South Coast District, with financial assistance from EPA and substantial funding of their own has carried out a study addressing the "Magnitude of Ambient Air Toxics Impact form Existing Sources in the South Coast Air Basin" (Also, known as "MATES"). The methods employed by Los Angeles, and the general purposes of the study are very much in line with EPA's urban air toxic program objectives, though much more extensive and elaborate than might be needed in many smaller areas. Thus, EPA is making this report available to other State and local agencies. The rest of this document is a reproduction of Working Paper Number 3 from the South Coast study. This report is reproduced and distributed with the permission of the South Coast Air Quality Management District to be used as a basis for further study by various interested State and local agencies who may be contemplating work on their own.

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July 25, 1988

Edward J. Lillis, Chief
Noncriteria Pollutant Programs Branch
Air Quality Management Division
Office of Air Quality Planning and Standards
U. S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Dear Mr. Lillis:

The South Coast Air Quality Management District is pleased to endorse your proposed publication of the District's report entitled "The Magnitude of Ambient Air Toxics Impacts From Existing Sources in the South Coast Air Basin" under EPA cover with a title acknowledging our authorship. Please send us a copy of this publication when completed.

The District continues to improve the regional exposure and risk assessment model used in the MATES study. Although it has proven to be a very useful tool in prioritizing air toxic species, the model in its current form assumes the population stays in the home all the time and that the only exposure route is inhalation. This model will be improved to account for (1) mobility, (2) microenvironments, and (3) multi-media exposure. Results of this effort will be available by spring of next year.

If we can be of further assistance to you or any other state and local agencies, please feel free to call Ditas Shikiya at (818) 572-2119. We look forward to continued communication regarding this common interest.

Sincerely,

Carolyn L. Green

Carolyn L. Green
Deputy Executive Officer
Office of Planning & Analysis

CLG:DS

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ACRONYMS USED IN WORKING PAPER NO. 3

AB	ASSEMBLY BILL
AEIS	AUTOMATED EQUIPMENT INFORMATION SYSTEM
AQMP	AIR QUALITY MANAGEMENT PLAN
ARB	AIR RESOURCES BOARD
CAG	CARCINOGEN ASSESSMENT GROUP
DIME	DUAL INDEPENDENT MAP ENCODING
DOHS	DEPARTMENT OF HEALTH SERVICES
EIS	EMISSION INVENTORY SYSTEM
EPA	ENVIRONMENTAL PROTECTION AGENCY
GBF	GEOGRAPHIC BASIC FILE
HEM	HUMAN EXPOSURE MODEL
MATES	MULTIPLE AIR TOXICS EXPOSURE STUDY
OAQPS	OFFICE OF AIR QUALITY PLANNING AND STANDARDS
POTW	PUBLICLY OWNED TREATMENT WORKS
ROG	REACTIVE ORGANIC GASES
SCAG	SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS
SCREAM	SOUTH COAST RISK AND EXPOSURE ASSESSMENT MODEL
SHEAR	SYSTEMS APPLICATIONS HUMAN EXPOSURE AND RISK MODEL
SMSA	STANDARD METROPOLITAN STATISTICAL AREA
UTM	UNIVERSAL TRANSVERSE MERCATOR

EXECUTIVE SUMMARY

Control of toxic air pollutants (or air toxics) is currently achieved by continued reduction of industrial and mobile source emissions through control measures already in place or proposed for implementation. Such measures include regulations for criteria pollutants which reduce emissions for a broad range of particulate and gaseous compounds that are toxic. However, some of these measures may at the same time result in increased emissions of toxic air pollutants or precursors.

An analysis of potential positive or adverse effects on ambient air toxics concentrations of AQMP control strategies for criteria air pollutants is a necessary part of the AQMP development effort. Control strategies specifically for air toxics will be developed through the California Air Resources Board (ARB) air toxics contaminant program (AB 1807, Health and Safety Code Section 39650, et seq) and by the District as more comprehensive toxic emissions data become available.

In order to determine if existing or proposed control approaches for criteria pollutants are adequate to protect public health from exposure to air toxics, an understanding of the air toxics problem in the South Coast Air Basin (Basin) is needed. However, standard techniques currently available for assessing such risks cannot be specifically applied to an urban area such as this Basin. Through an Environmental Protection Agency (EPA) funding for a Multiple Air Toxics Exposure Study (MATES) in the Basin, a method to identify the magnitude of the air toxics impacts from individual chemical species and emissions source categories was developed and applied to this Basin. This method integrates ambient concentration, population distribution, and health risk data for individual chemical species into regional estimates of inhalation exposure, risk, and number of excess cancer cases.

The model used in this method was developed from the Human Exposure Model (HEM) and includes features for: (1) defining the receptor network, (2) conducting dispersion calculation, and (3) determining population exposure and areawide risks. This model was developed with the concept that all necessary input data on emissions, meteorology, and population are readily available, such that it can be applied to other urbanized areas in the United States.

The estimation of population exposure to one or more air toxics is conducted by first using dispersion modeling to calculate the long-term concentrations at centroids of census areas and then multiplying the calculated concentration with the population that each centroid represents. The areawide risks, in terms of incremental cancer cases, are then calculated by multiplying the population exposure with the chemical-specific unit risk factor. A linear response relationship is assumed and the exposure/risks associated with multiple sources and species of air toxics are considered additive.

The enhanced HEM model (called the South Coast Risk and Exposure Assessment Model, SCREAM) can be used to apportion the number of excess cancer cases by source category and by pollutant, and to identify high-risk chemical species and source categories. It can also be used to identify high-risk locations and to estimate control measure effectiveness in reducing exposure, cancer risk, and number of cancer cases.

Of the 20 air toxics studied, benzene and hexavalent chromium appear to have the greatest impact on the Basin's population. Almost the entire population is exposed to ambient benzene and hexavalent chromium concentrations corresponding to an upper-bound risk of 1×10^{-4} or higher.

The assumptions used in developing the model and those associated with the quantification of cancer risk inject a considerable degree of uncertainty into the analysis. Some assumptions lead to a potential underestimation of the risk to the population, while others result in an upper-bound estimate of the cancer risk. An understanding of these assumptions is necessary to evaluate the uncertainty associated with the estimated risks.

Results of this study indicate the relative importance of the individual carcinogenic species and the relative contribution of individual source categories to the total risk from a specific pollutant. This information can be used in developing and prioritizing an air toxics control program and in evaluating potential air toxics impacts from existing or proposed control approaches and sources.

CHAPTER I
INTRODUCTION

I.1 OBJECTIVES

Current regulations for criteria air pollutants reduce emissions for a broad range of particulate and gaseous compounds that are toxic. These regulations have been adopted based on meeting air quality standards rather than assessments of health risk due to toxicity. An example is the use of alternative solvents and surface coatings to reduce emissions of reactive organic gases which are precursors to ozone formation. Changing paint formulations or using alternative coatings and solvents which are photochemically less reactive could produce other environmental impacts including adverse toxic effects. In view of the current concern for toxic health effects, an analysis of potential adverse consequences related to air toxic emissions will be made prior to a recommendation to implement Air Quality Management Plan (AQMP) control strategies.

This report presents the results of a study quantifying the magnitude of population exposure from existing point, area, and mobile source emissions of 20 selected air toxics. This understanding of the existing air toxics problem in the South Coast Air Basin (Basin) will be useful in evaluating AQMP control strategies for criteria pollutants for their potential to reduce or increase emissions of toxic air pollutants. An analysis of potential positive or adverse changes to ambient air toxics concentrations as a result of AQMP strategies will prevent the inadvertent replacement of the health threat from criteria pollutants with the health threat from ambient air toxics.

The method described in this report would establish a scheme to rate toxic air pollutants according to a number of selected factors which will be determined based on this study and on existing or proposed control measures. Control strategies specifically for air toxics will be developed as needed by the District (see state's program below) and as more comprehensive, Basin-specific toxics emissions data bases become available.

Under the state's toxic air contaminant program (Assembly Bill 1807, Health and Safety Code Section 39650 et seq), the California Air Resources Board (ARB), with the participation of the local air pollution control districts, evaluates and develops any needed control measures for air toxics. Measures for the control of benzene emissions have been developed and control measures for chromium emissions are currently being developed. The information from this report will also be useful to the ARB and the California Department of Health Services (DOHS) in their identification and assessment of potential health risks of air toxics as required by AB 1807.

I.2 BACKGROUND

The Environmental Protection Agency (EPA), using standard risk assessment techniques, prepared the most comprehensive report to date to characterize the risk associated with exposure to carcinogens (EPA, 1985). This study, known as the "Six-Month Study," was national in scope and used existing data extrapolated to a much larger geographical area to estimate exposure and risk. The limitation of the available data precludes performing specific risk assessments for most urban areas, for many substances, and for many large sources of air toxics risk. EPA's objectives were not intended for regulatory support but only for guidance in policy decisions and further studies.

To satisfy the need of a local air regulatory agency, both in terms of air quality planning and for permit application review, a method was developed to characterize existing ambient concentrations of carcinogenic air pollutants and to summarize the present understanding of the magnitude of the air toxics problem in the Basin.

This study focuses on cancer risks only because the analysis techniques for carcinogenic effects are sufficiently developed to allow a rational and defensible basis for regulation. For example, use of a non-threshold assumption in estimating cancer risk has broad scientific support. It is also generally accepted that a substance that causes cancer in test animals is likely to be carcinogenic to humans as well; this has not been established for other health effects. There is also a well-established mathematical model for estimating risk at low doses; this is not the case for other effects. More work is needed to establish models and methods for assessing quantitatively the risk of other health effects.

The individual lifetime cancer risks reported in this study could be viewed in the context of other cancer risks. The overall probability of contracting cancer is approximately 250,000 cases per million population over a lifetime (ARB and DOHS, 1986). Doll and Peto (1981) have estimated that about 65 percent of annual cancer deaths appear to be related to smoking or diet, each of which are predominantly affected by personal choice. The number of cancer cases for all exposures to environmental pollution is reported to be about two percent of total cancer incidences and is generally due to involuntary exposure to air toxics emissions. This translates into approximately 50,000 excess cancer cases in the Basin over 70 years or about 700 cases annually given the current population. The cancer cases calculated in this report are only a small portion of the cancer risks from all environmental pollutants but are those over which the District or ARB has regulatory authority for protecting public health.

CHAPTER II
AMBIENT CARCINOGEN CHARACTERIZATION METHOD

Estimating the cancer risks from exposure to an environmental pollutant requires the following information:

- An estimate of the carcinogenic potency of the pollutant;
- An estimate of the ambient concentrations that individuals or groups of individuals may inhale; and
- An estimate of the number of individuals that are exposed to those concentrations.

The method discussed in this report uses the above information and is consistent with the EPA-proposed guidelines for air toxics assessment (Federal Register, 1986). It utilizes an urban air toxics exposure and risk model developed specifically for the Basin to determine the risks associated with exposure to ambient toxics emitted from both stationary and mobile sources in the Basin.

The District's method integrates ambient concentrations, population distribution, and carcinogenic potency data for individual species (in the form of unit risk factors) into regional estimates of exposure, risk, and cancer cases to provide the following:

- Estimates of regional impacts from existing sources of carcinogens quantified in terms of population exposure, individual cancer risk, and number of excess cancer cases;
- Apportionment of the number of excess cancer cases by source category, including identification of high-risk species and source categories;
- Identification of high-risk locations due to specific sources or groupings of multiple sources;
- Estimates of the effectiveness of control measures in reducing exposure, risk, and number of excess cancer cases;

Figure II-1 shows the flow of information in the characterization method. As shown, ambient concentrations of carcinogens were estimated using: (1) ambient measurements, (2) modeling, and (3) a literature survey. Annual average ambient concentrations determined by measurements in the Basin or predicted by regional modeling of emissions sources are considered as primary sources of information. A literature survey of ambient data available for areas in or outside this Basin, but which are not representing an annual average, are used for analysis as secondary sources of information.

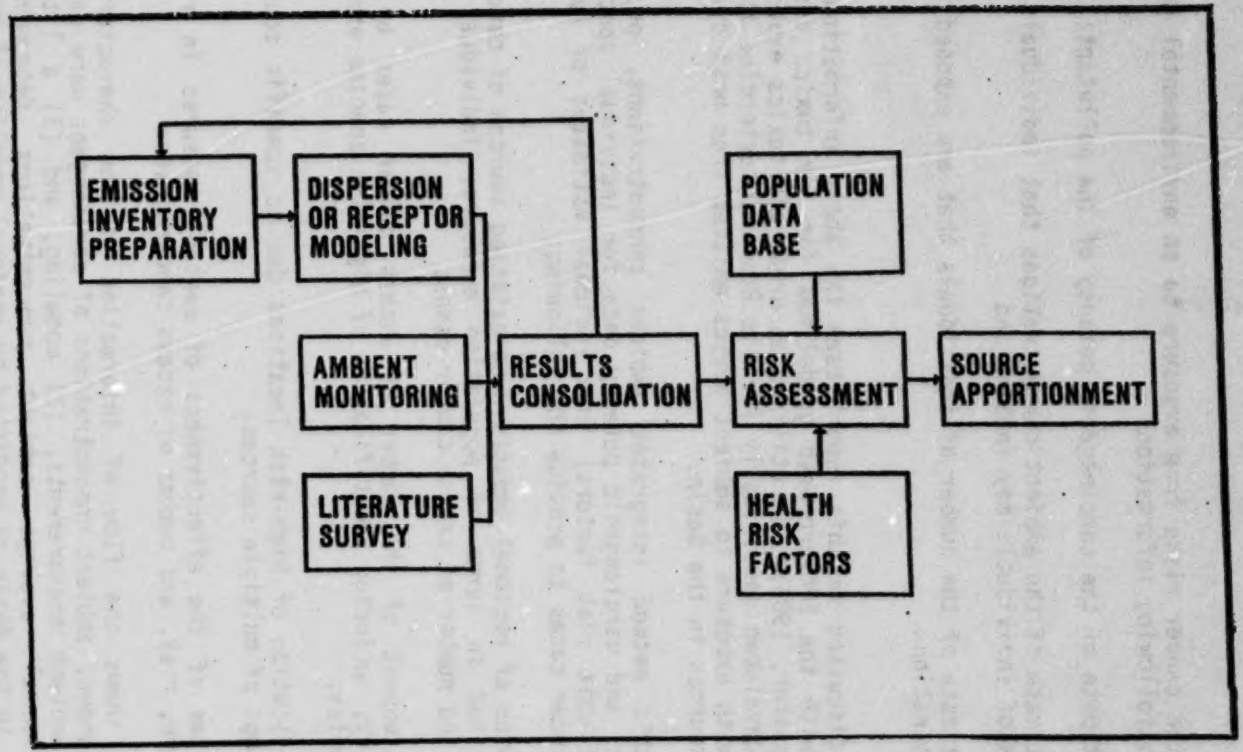

EMISSION INVENTORY PREPARATION
DISPERSION OR RECEPTOR MODELING
AMBIENT MONITORING
LITERATURE SURVEY
RESULTS CONSOLIDATION
POPULATION DATA BASE
RISK ASSESSMENT
HEALTH RISK FACTORS
SOURCE APPORTIONMENT

FIGURE II-1

AMBIENT CARCINOGEN RISK ASSESSMENT APPROACH

Ambient measurement and modeling are complementary in this process. Ambient measurements of carcinogens quantify the total impact of emissions from all sources. If the deviation between monitoring results and model-predicted concentrations is larger than those that can be explained by the uncertainties of modeling techniques, the accuracy of the emissions data might be in question. Modification of the emissions data may be needed as shown by the feed-back loop in Figure II-1.

An advantage of modeling techniques over ambient measurements is that additional information such as apportioning the number of cancer cases in the region by source category or by individual chemical species are provided. This apportionment identifies high-risk chemical species and source categories and ultimately can be used to estimate the effectiveness of control measures in reducing cancer impacts.

The cancer potencies or unit risk factors of most of the pollutants covered in this report were those developed by EPA's Carcinogen Assessment Group (CAG) and by the DOHS pursuant to AB 1807. The unit risk factor represents the probability of cancer cases, not deaths, and is defined by CAG as the chance of contracting cancer from a 70-year lifetime exposure to a concentration of 1 ug/m^3 of a given substance.

The two measures of risks calculated in this report are the lifetime individual risk and the estimated number of excess cancer cases. Lifetime individual risk is a measure of the probability of an individual contracting cancer as a result of exposure to an ambient concentration of an air pollutant or several air pollutants over a 70-year period. The number of excess cancer cases is the estimate for the entire affected population and is calculated by multiplying the individual cancer risk in a receptor area by the number of people exposed in that receptor area.

CHAPTER III
MODEL DEVELOPMENT

Estimating population exposure to emitted air toxics has been investigated previously through dispersion modeling and concentration-population integration. Anderson, et al. (1980) developed and applied the Human Exposure Model (HEM) under contract to EPA's Office of Air Quality Planning and Standards (OAQPS). The analyses were national in scope and were conducted under the OAQPS mandate to review chemicals in use for potential regulation for National Emissions Standards for Hazardous Air Pollutants (NESHAPs) development under Section 112 of the Clean Air Act. The analyses were intended as a preliminary screening for scoping and prioritizing regulatory attention among the 35 chemicals studied.

HEM numerically combines the results of modeled concentration distributions and population data files to quantify population exposure to air toxics. However, the additive impacts of multiple chemicals emitted by a source and the additive impacts of multiple nearby sources are not calculated. Anderson and Lunberg (1983) enhanced the HEM package by adding the capability to produce combined exposure and risk estimates from multiple sources of all studied toxic species. This enhanced model is called Systems Applications Human Exposure and Risk (SHEAR).

Several characteristics of HEM and SHEAR are not adequate for applications in the Basin either for air quality planning or permit processing purposes. For area sources, both models use calculated city-wide concentrations and city-wide average population density. For point sources, population density data from the United States Census Bureau files are incorporated only to the Block Group and Enumeration District level. The meteorological data base for HEM and SHEAR dispersion models includes STAR tabulation for only three sites in the Basin, even though detailed localized meteorological data may be available for a large number of sites. Emission inventory for air toxics in the Basin contains more detailed information on specific point sources and general prototype sources than can be handled by HEM and SHEAR.

For these reasons HEM was further enhanced and tailored to the Basin for air quality planning purposes. This effort requires the use of the most detailed population data available and a more refined treatment of temporal and spatial emission patterns. This second enhancement of HEM (Liu, et al, 1986) is called the South Coast Risk and Exposure Assessment Model (SCREAM).

III.1 POPULATION DATA BASE

The location and population of all census areas are required input for SCREAM. The following four levels of population units were selected:

- Place (Incorporated or Census Designated)
- Census Tract and Minor Civic Divisions
- Block Group (BG) and Enumeration District (ED)
- Street Block

The 1980 United States census population of all these levels of disaggregation are available at the Bureau of Census' Summary Tape File 1 (USBC, 1981). In 1980, there were 245 places, 3,198 census tracts, and 93,630 street blocks in the Basin.

The locations of centroids are available at the BG/ED level. In order to obtain the same information for street blocks, the United States Bureau of Census' Geographic Basic File/Dual Independent Map Encoding GBF/DIME files (USBC, 1980) were used. A geographic base file is a map in a form that is computer readable. Dual Independent Map Encoding is a method of representing map features numerically. GBF/DIME files are organized by Standard Metropolitan Statistical Areas (SMSAs). The following three SMSAs cover the entire Basin and the mountain and desert areas to the east and north of the Basin:

Los Angeles - Long Beach
Anaheim - Santa Ana - Garden Grove
Riverside - San Bernardino - Ontario

There are a total of 357,714 records in the GBF/DIME files for the three SMSAs. Each record identifies a segment of a feature on the map by its node points (a "from" node and a "to" node), address range (for both the odd and even sides), segment type (street, political boundary, streams, etc.), and other data (census tract and left and right block numbers) on each sides.

The following steps were followed to determine the centroid for each street block based on the information contained in the GBF/DIME records:

- Specific data items such as census tract code, block numbers (both sides), the ID number, latitude and longitude for both "from" and "to" node were extracted from the original file for each SMSA. The geodetic coordinates were then converted into UTM coordinates.
- Each record was then split into two separate records; one for each block on each side of the segment with all other information attached.
- The resulting files were sorted by census tract and street block numbers and contained records of all blocks in a sequential manner. Duplicate records were eliminated.

- Records related to the same block were processed to enclose the boundary surrounding the specific block by linking "from" and "to" nodes on each record. The centroids for the block were then calculated based on the nodes on the enclosed boundary.

Four files were created containing data on both the 1980 population and the UTM coordinates of the centroids of each: (1) block, (2) BG/ED, (3) census tract, and (4) place. An additional file was created containing similar information for the population in GBF/DIME areas.

Annual growth factors derived from the projection compiled by the Southern California Association of Governments (SCAG) at the place level were used to forecast population.

III.2 METEOROLOGICAL DATA BASE

HEM and SHEAR use meteorological data in the form of STAR tabulation (frequency of occurrences of various meteorological conditions) for only three sites in the Basin. Because of the abundance of the long-term meteorological data collected in this Basin and the importance of terrain on meteorology, the meteorological data base was expanded to 16 sites, each representing a specific source-receptor area, to cover the entire Basin.

Another enhancement made was the creation of seasonal- and diurnal-specific STAR tabulation to include certain source types which have emissions in the winter periods only and where solvent usage occurs mostly during working hours.

III.3 EXPOSURE ASSESSMENT

The receptors used in dispersion modeling of emissions from specific and prototype sources include centroids of all four levels of population disaggregation. The model, by default, dynamically locates the population centroids within a pre-determined radius from the source studied. Centroids for all street blocks within a radius of 2.5 km of the sources, all BG/ED's within 10 km, and all census tracts within 20 km, were used as model receptor areas. If desired, the model can specify the radii for population unit transition or specific concentration thresholds or risk levels for determining the transition from a finer level of population to a coarser one. The assessment of impacts from mobile sources uses the centroids of all census tracts as the common basis for matching the concentration estimates and the population distribution.

III.4 SUMMARY OF ENHANCEMENTS AND OUTPUT

SCREAM contains the following enhancements:

- Census data at the street block rather than block group level;
- City-specific growth projections;
- Extensive site-specific meteorological data for dispersion modeling;
- Special gravity treatment to locate prototype sources such as service stations.

The types of output generated by SCREAM consist of:

- Population distribution in close proximity of specific point sources;
- Tabulation of the number of people exposed to specific ambient carcinogens above a pre-defined concentration;
- Tabulation of exposure, cancer risk, and number of cancer cases with different re-defined thresholds by source category and chemical species;
- Isopleth plots of concentrations, exposure, and cancer risk patterns related to emission of specific chemicals from specific point sources;
- Isopleth plots of concentration, exposure, and cancer risk patterns on a regional basis for specific chemicals or for all defined species.

CHAPTER IV
EMISSIONS DATA

A detailed emissions data base was developed as input data for SCREAM and discussed in the following sections.

IV.1 EMISSION INVENTORY METHODOLOGY

The District's first toxic air pollutant emissions inventory was compiled for 30 toxic air pollutants for the year 1982 (Zwiacher, et al., 1983) for stationary sources only. For ten of the pollutants, the data were generated from emissions compiled from the District's computer data bases, including the Automated Equipment Information System (AEIS) and Emission Inventory System (EIS) files and 1982 Emission Fee Reports. For the remaining 20, emissions data were obtained from a mail survey of 1606 companies in the Basin and followed by literature searches, and letter and telephone inquiries.

For the MATES, 20 of the pollutants (shown in Table IV-1) were updated to 1984 (Zwiacher, et al., 1985). In addition, mobile source emissions data for 12 of the 20 toxics under study were compiled.

IV.1.1 Stationary Source Emissions

The data for 1244 point sources were entered into a computer file along with company name, address, AEIS identification number, and Universal Transverse Mercator (UTM) coordinates. Over the last year additional corrections have been made to the inventory. Specific stack parameters for individual power plants and a generic set of parameters used for all refineries are presented in Table IV-2.

IV.1.2 Mobile Source Emissions

Emissions of potentially toxic air pollutants from mobile sources were estimated for on-road motor vehicles only. Emission rate data were unavailable for other mobile sources (i.e., aircraft, locomotives, ships, and off-road vehicles). Estimated motor vehicle emission factors for 12 of the 20 pollutants under study were provided by ARB and are shown in Table IV-3. Emissions of these compounds result from combustion and evaporation of motor vehicle fuels. The emission factors were provided as a weight percent of total hydrocarbons (THC) except as indicated in Table IV-3.

ARB's program BURDEN calculates estimates of motor vehicle emissions by vehicle type (automobiles, trucks, and motorcycles), fuel type (gasoline and diesel), emission type (exhaust, hot soak evaporation, and diurnal evaporation), control technology (catalyst and non-catalyst), and

TABLE IV-1
TOXIC AIR POLLUTANTS STUDIED IN THE SOUTH COAST AIR BASIN

METALS	ORGANICS
Arsenic	Benzene
	Carbon Tetrachloride
Beryllium	Chloroform
	Ethylene Dibromide
Cadmium	Ethylene Dichloride
	Methyl Bromide
Chromium	Methylene Chloride
	Perchloroethylene
Lead	Toluene
	1,1,1-Trichloroethane
Mercury	Trichloroethylene
	Vinyl Chloride
Nickel	Xylenes

TABLE IV-2
STACK PARAMETERS

FACILITY	AEIS ID#	HEIGHT (FEET)	DIAMETER (FEET)	VELOCITY (FT/MIN)	TEMPERATURE (^{o}F)
POWER PLANT BOILERS					
SCE-SAN BERNARDINO	12803	130	10.0	2040	284
SCE-REDONDO	14052	200	12.0	4400	273
SCE-HUNTINGTON BEACH	8364	203	17.3	5118	275
SCE-ETIWANDA	24296	176	12.0	3420	264
SCE-ALAMITOS	8028	200	14.0	4422	250
SCE-EL SEGUNDO	18763	200	12.0	3977	290
SCE-HIGH GROVE	15872	100	10.0	1920	311
ALL REFINERY PROCESSES					
	800080 800081 800089 37368 986 800055 7048 800043 800184 16040 21822 1356 14751 800116 24035 11828 3458	100	7.5	700	400

TABLE IV-3

EMISSION FACTORS FOR MOTOR VEHICLES

(Data in wt% of total hydrocarbons (THC) except where specified)

	Exhaust					Evaporative		
	OC	TWC	CAT	Non-Cat	Diesel	Diurnal	Hot-Soak	Total
Benzene			4.1	4.2	2.3	ND	ND	1.2
Cadmium (Wt% of PM)	ND	ND	.020[e]	.020[e]	.021	---	---	---
Chromium (Wt% of PM)	ND	ND	.001[a]	.001[a]	.19	---	---	---
Chloroform (vol. ppt)	---	---	6,200	79	ND	---	---	---
Ethylene Dibromide	---	---	---	.014	---	ND	ND	.009
Ethylene Dichloride	---	---	---	.036	---	ND	ND	.051[b]
Inorganic Lead	(see foot notes d)							
Nickel (Wt% of PM)	ND	ND	.006[a]	.006[a]	.012	---	---	---
TCA	ND	ND	ND	ND	ND	ND	ND	ND
TCE	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	7.3	6.6		8.2	1.9[c]	.70[c]	9.1[c]	8.0
Xylenes	5.3	4.0		6.7	.30[c]	.10[c]	10.8[c]	

OC: Oxidation Catalyst
TWC: Three-Way Catalyst
Cat: Catalyst
Non-Cat: Non-Catalyst

TCA: 1,1,1-Trichloroethane
TCE: Trichloroethylene
PM: Particulate Matter
ND: No data

---

a Data reported for Leaded/Unleaded Gasoline Composite.

b Emission Factor was derived from EDB emission factor and the ratio of EDB to EDC in gasoline.

c Modeling Emission Data System, Technical Support Division, Analysis and Modeling Branch, Sacramento, CA.

d Emission factors are not presented here; however emissions can be calculated from the amount of lead in gasoline. 97 percent of lead in gasoline is emitted from vehicular exhaust for cars with mileage over 30,000 miles (Ref. 12).

e Cadmium content of gasoline is reported as 0.020 mg/l (Ref. 13), assuming all cadmium in gasoline is emitted, cadmium emission factor in vehicular exhaust is 0.020 mg/l.

Source: CARB, 1985.

emittant (THC, PM, CO, NO_x, and SO_x) for any given year. BURDEN was run for 1984 using emission factors from ARB's emission factor program EMFAC6D. The emissions data from the BURDEN output for the appropriate vehicle types, fuel types, emission types, and control technologies were applied to the emission rates in Table IV-2 to calculate the ratio of emissions to THC emissions for motor vehicles. The resulting fractions applicable to the Basin in 1984 are shown below:

Benzene	3.4×10^{-2}
Cadmium	3.4×10^{-5}
Chloroform	2.9×10^{-9}
Chromium	6.5×10^{-5}
Ethylene Dibromide	5.9×10^{-5}
Ethylene Dichloride	2.1×10^{-4}
Nickel	1.2×10^{-5}
Toluene	7.0×10^{-2}
Xylenes	4.4×10^{-2}

Data in the 1979 emissions inventory and 1987 forecast for lead in the Basin were interpolated to estimate 1984 lead emissions from motor vehicles. The ratio of lead to THC was calculated to be 0.010.

The above factors were applied to the Basin total THC on-road motor vehicle emissions (556 tons/day) and to the gridded ROG emissions.

IV.2 SUMMARY OF EMISSIONS

A summary of the 1984 toxics emissions inventory is presented in Table IV-4. Area sources and those small point sources which are too numerous to individually spatially allocate are combined under the area source emissions column.

Point sources are primarily associated with emissions of arsenic, beryllium, mercury, methyl bromide, nickel, and vinyl chloride. Emissions of metal species were contributed by combustion, plating, and other processes. Methyl bromide is used as a soil and space fumigant and in organic synthesis. Vinyl chloride is emitted from polyvinyl chloride production in addition to a small, but poorly quantified, contribution from municipal and hazardous waste landfills.

Area sources contributed the majority of methylene chloride, perchloroethylene, and trichloroethylene emissions. These substances are predominantly used in metal degreasing, solvent extractions, and dry cleaning.

Motor vehicles comprised the major sources of cadmium, ethylene dibromide, ethylene dichloride, lead, toluene, and xylene emissions. Each of these substances is a constituent of gasoline and diesel fuels. Benzene emissions are split almost evenly between mobile sources and

TABLE IV-4

TOXICS EMISSIONS OF TWENTY SPECIES IN THE SOUTH COAST AIR BASIN IN 1984

Species	Emissions (tons/year) Point	Area	Mobile	Total
Arsenic	0.047	-	-	0.047
Benzene	118.	7870.	6910.	14,898.
Beryllium	0.037	-	-	0.037
Cadmium	1.12	-	6.91	8.03
Carbon Tetrachloride	3.20	-	-	3.20
Chloroform	0	-	0.0006	0.0006
Chromium	16.0	-	13.2	29.2
Ethylene Dibromide	1.09	-	12.0	13.1
Ethylene Dichloride	3.53	-	42.7	46.2
Lead	14.5	-	2030.	2045.
Mercury	0.13	-	-	0.13
Methyl Bromide	24.4	-	-	24.4
Methylene Chloride	4780.	10,200.	-	14,980.
Nickel	5.40	-	2.44	7.84
Perchloroethylene	3970.	8850.	-	12,820.
Toluene	714.	276.	14,200.	15,190.
1,1,1-Trichloroethane	8590.	6150.	-	14,740.
Trichloroethylene	9.52	546.	-	556.
Vinyl Chloride	1.37	-	-	1.37
Xylenes	230.	185.	8950.	9365.

- = no data available

area sources such as gasoline marketing, stationary gasoline engines, crude oil production, and agricultural burning.

Some emissions sources have not yet been adequately assessed, including municipal and hazardous waste landfills, while other sources have not been incorporated. Although stationary source emissions of chloroform are listed as zero in Table IV-4, several sources may have significant emissions of chloroform. These sources include publicly owned treatment works, sewer lines, swimming pools, showers, laundry machines, and power plant cooling towers. Publicly owned treatment works (POTWs) are also thought to be a significant source of vinyl chloride nationally (Versar, 1984); however, knowledge of existing industrial sources of discharge into local sewer systems and recent downwind testing do not indicate substantial vinyl chloride emissions from POTWs in this Basin (Roberts, 1985). Further source testing would need to be conducted to develop emission factors for these and other sources and to estimate routine emissions of chloroform and vinyl chloride as well as other air toxics.

IV.3 SPATIAL ALLOCATION OF EMISSIONS

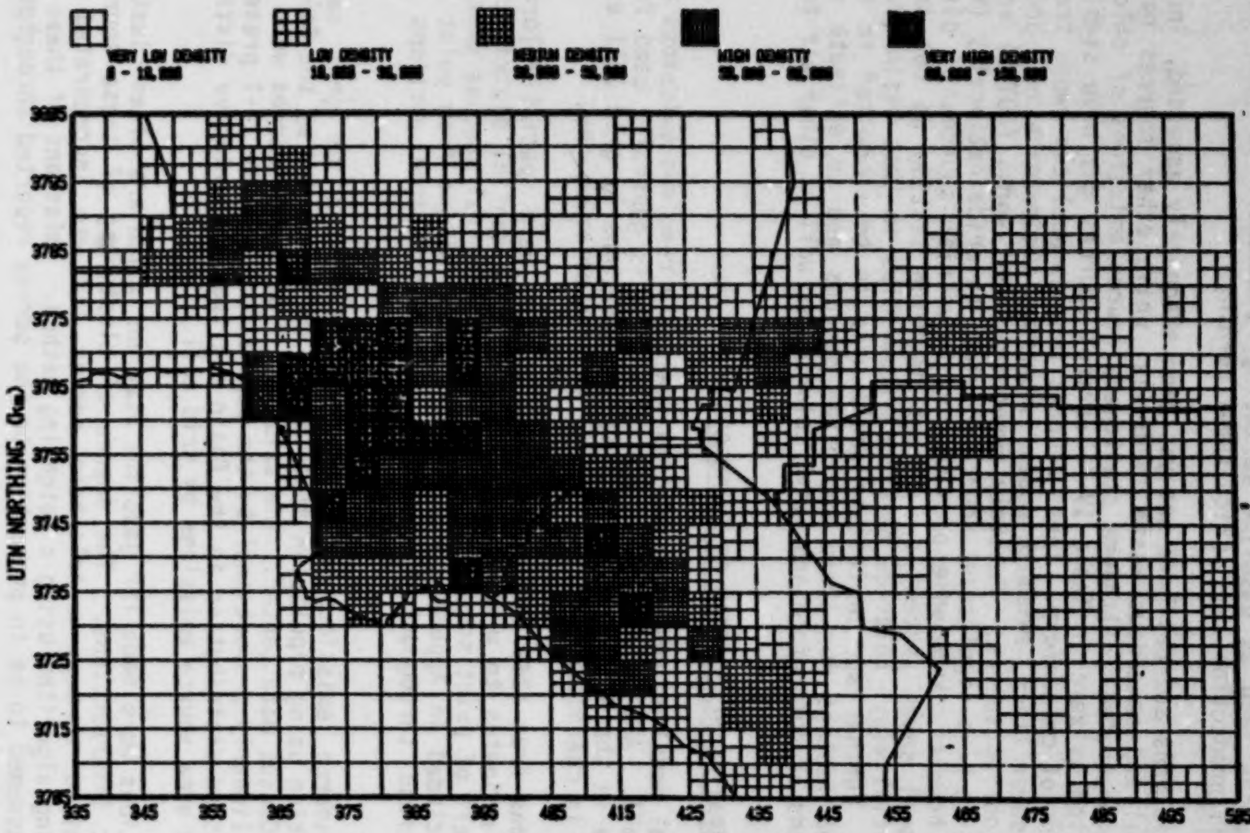
Regional modeling analysis requires spatially resolved emissions data by grid cell. A 5 km by 5 km grid cell system is generally used for this purpose in the Basin. Maps showing the emissions by grid cell are also useful in characterizing the spatial pattern of emissions.

Emissions from 1244 individual point sources were spatially located by UTM coordinates to within 0.1 kilometer. The spatial distributions by grid cell of point source emissions of each chemical species under study are included in Appendix A. Most of the emissions from point sources are spread throughout the coastal and metropolitan portions of the Basin.

Area source emissions were spatially allocated to grid cells by population using population distribution data provided by the California State Census Data Center. The emissions from these sources were assumed to be linearly proportional to the population. Figure IV-1 presents the population distribution in the Basin and thus the relative distribution of the area source emissions by grid cell.

Exceptions were made for gasoline stations which are often clustered at street intersections. The degree of clustering of these sources was determined through a telephone survey and was incorporated in the modeling algorithm using a weighting method. Emissions of these sources were assumed to be in proportion to the survey reported throughputs.

Annual average emissions of reactive organic gases (ROG) from motor vehicle sources in the Basin for 1984 have been gridded into 5 km by 5 km cells for the entire Basin. These emissions are presented by grid cell in Figure IV-2. These emissions were further divided into 1 km by 1 km cells by assuming that each of the 25, 1 km by 1 km cells within



VERY LOW DENSITY
0 - 10,000
LOW DENSITY
10,000 - 30,000
MEDIUM DENSITY
30,000 - 50,000
HIGH DENSITY
50,000 - 80,000
VERY HIGH DENSITY
80,000 - 100,000
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE IV-2
SPATIAL DISTRIBUTION OF POPULATION DENSITY

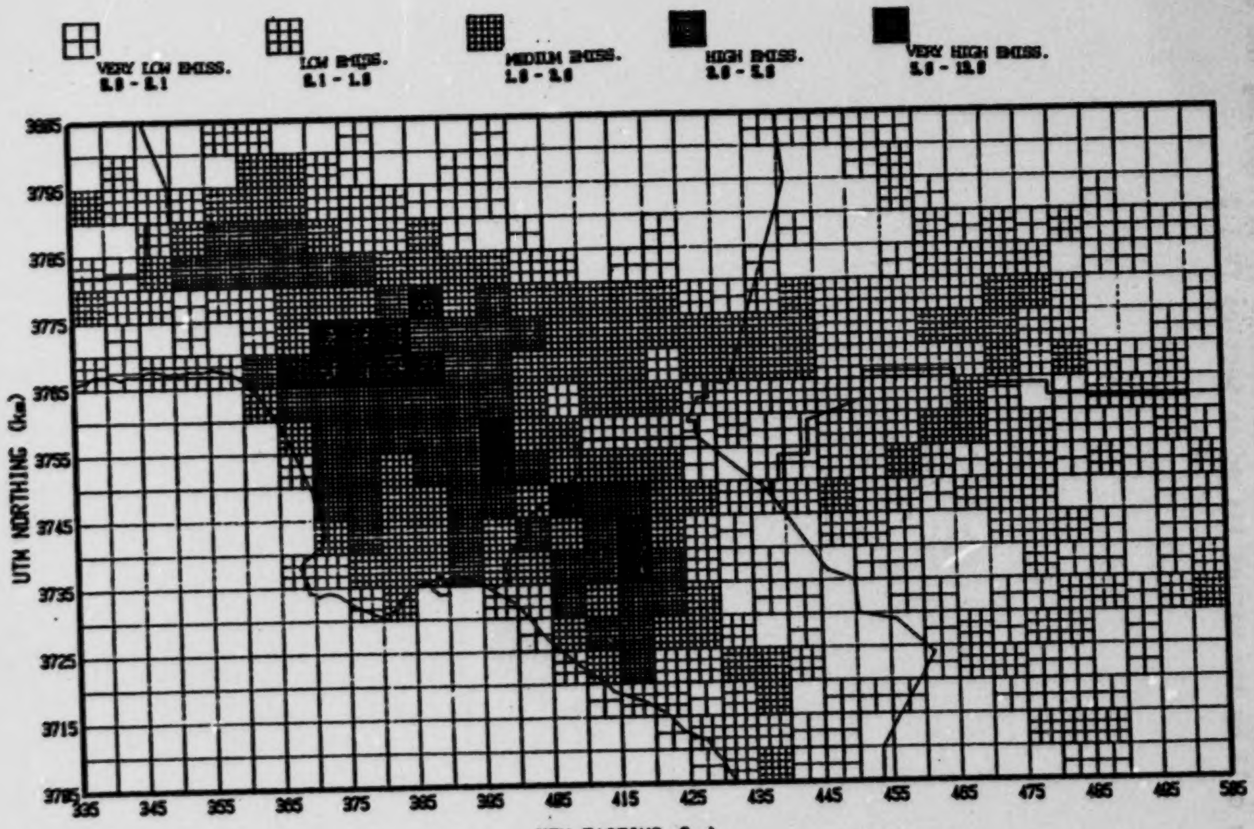

VERY LOW EMISS.
0.0 - 0.1
LOW EMISS.
0.1 - 1.0
MEDIUM EMISS.
1.0 - 2.0
HIGH EMISS.
2.0 - 5.0
VERY HIGH EMISS.
5.0 - 10.0
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE IV-3
DISTRIBUTION OF MOBILE SOURCE EMISSIONS OF REACTIVE ORGANIC GASES

any 5 km by 5 km cell has equal emissions. The emissions of individual toxic species in each cell were calculated by multiplying THC emissions in any cell by the ratios listed in Section IV.1.2.

CHAPTER V
AMBIENT DATA

The District and ARB have been conducting continuous long-term ambient air monitoring programs for several toxic air pollutants in the Basin. EPA, through its National Air Surveillance Network, also monitors continuously for several airborne metals in the Basin. Using these data, annual average ambient concentrations for several organic and metal air pollutants at several locations in the Basin have been estimated for 1985. District-wide population-weighted average concentrations were also estimated for most of the compounds.

Since none of the three toxic air pollutant monitoring networks measured ambient formaldehyde, a brief discussion of selected short-term air sampling studies conducted in the Basin for this compound are summarized to provide an indication of representative ambient concentrations in the region.

V.1 CONTINUOUS MONITORING NETWORK

Figure V-1 shows the location of each continuous toxic air pollutant monitoring station in the Basin. All monitoring sites are located at existing District criteria pollutant stations except for El Monte. The District collects samples for 11 organic gases about once every two weeks at four of these stations. ARB collects samples for eight organic gases at about the same rate as the District and for six metals about once per week at the other five sites. EPA samples for 14 metals and benzo(a)pyrene about every 10 to 12 days at two sites.

Data gaps were present in all three network data bases. These gaps were more extensive within the District and ARB data bases. For example, in 1985, the District did not start collecting data until the beginning of March. Gaps in the ARB data base were also present during a three-month period starting in June for seven organics, and during a 22-week period starting in July for three metal pollutants.

V.1.1 Annual Average Ambient Concentrations

A range of arithmetic annual average values was calculated when one or more observations for a particular pollutant were measured below minimum detection limits. That is, low and high average values were calculated assuming that all below-detection-limit values were equal to zero and equal to the detection-limit value, respectively.

ARB and EPA reported one detection limit value for each pollutant; whereas, the District reported several because the limit changed from observation to observation depending on laboratory conditions existing at the time of sample analysis. Standard deviations were calculated for

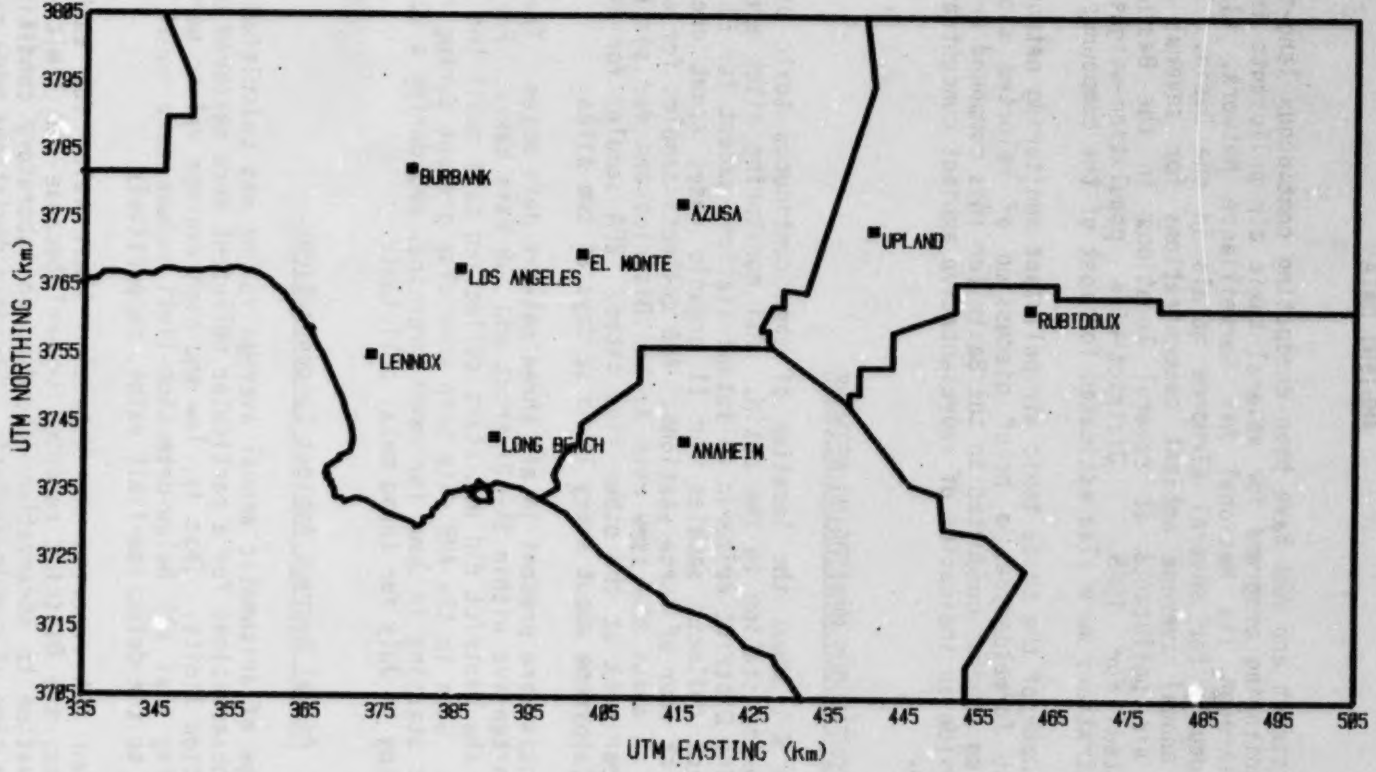

3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM NORTHING (km)
UTM EASTING (km)
BURBANK
AZUSA
UPLAND
LOS ANGELES
EL MONTE
RUBIDOUX
LENNOX
LONG BEACH
ANAHEIM

FIGURE V-1

AMBIENT AIR TOXIC MONITORING SITES IN THE SOUTH COAST AIR BASIN all pollutants with at least 10 percent or more of their observations above detection limits. For pollutants with less than 10 percent of their observations above detection limits, standard deviations were calculated using only those values above the detection limit. Data category codes are given based on the percentage of observations measured above detection limits: A--greater than 90 percent, B--less than 90 but greater than 10, and C--less than 10 percent. These categories provide a crude measure of confidence associated with the data.

Table V-1 and Table V-2 summarize the annual average ambient organic gases and ambient metals concentrations at several monitoring stations throughout the Basin in 1985. For organic gases the range of concentrations appears to vary from station to station. Ethylene dibromide concentrations, for example, vary by a factor of 20 between stations. ARB stations consistently measured lower levels than District stations for ethylene dibromide and perchloroethylene. Stations measuring benzene and carbon tetrachloride showed relatively comparable average concentrations. Concentrations of vinyl chloride, chloroform, ethylene dibromide, and ethylene dichloride were predominantly below detection limits for most stations.

Unlike organic gases concentrations, estimated average concentrations for metals did not vary by more than about a factor of three from station to station, except for arsenic and beryllium. EPA stations measured the highest concentrations for arsenic and the lowest for beryllium compared to ARB stations. The large variation in beryllium concentrations can be explained, in part, by the different detection limits reported by ARB and EPA. Most ARB samples were reported below detection limits which changed from 0.5 to 0.02 ng/m^3 after July 1. Therefore, since the former value was over 300 times greater than the EPA detection limit, estimated annual average values for ARB data are much higher than would otherwise be expected based on the more recent ARB detection limit. The quality of the annual average concentrations can be judged, in part, by looking at the number of detection limit observations for the various pollutant/station combinations shown in Table V-2. Arsenic, beryllium, and cadmium were observed at detection limit concentrations at many stations. Actual annual averages are probably somewhat lower than estimated.

Discerning spatial trends throughout the Basin for organic gases or metals is difficult because of the problem in determining if the spatial variations observed from station to station are due to either actual ambient conditions or differences in sampling and analytical procedures. The degree of comparability between the District and ARB sampling and analytical procedures for individual pollutants has not been clarified yet. Therefore, any conclusions based on an analysis of combined data from various data bases must be made with care.

TABLE V-1

1985 ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS OF VARIOUS TOXIC ORGANIC GASES IN THE SOUTH COAST AIR BASIN[a]

(concentration in ppbv)

	SCAQMD				ARB				
Pollutant	Anaheim	Azusa	Burbank	Lennox	El Monte	Long Beach	LA	Rubidoux	Upland
BENZENE									
Ave. Conc.	1.7-2.8	1.0-2.6	2.0-3.0	1.7-2.8	4.9	4.1	4.2	2.5	3.4
Std. Dev.	1.6	.92	1.3	1.5	2.6	1.9	2.2	1.3	1.4
Detection Limit[b]	2.0-4.0	1.0-4.0	1.0-3.0	2.0-3.0	.5	.5	.5	.5	.5
Sample Size/# < DL[c]	24/10	21/13	23/9	23/10	30/0	25/0	23/0	24/0	22/0
Data Category[d]	B	B	B	B	A	A	A	A	A
CARBON TETRACHLORIDE									
Ave. Conc.	.12	.12	.10	.11	.095	.10	.11	.099	.12
Std. Dev.	.038	.036	.023	.033	.024	.014	.016	.015	.073
Detection Limit	.016	.016	.016	.016	.004	.004	.004	.004	.004
Sample Size/# < DL	22/0	19/0	20/0	20/0	36/0	22/0	21/0	20/0	20/0
Data Category	A	A	A	A	A	A	A	A	A
CHLOROFORM									
Ave. Conc.	.045-.30	.053-.29	.018-.24	.063-.27	.063	.082	.11	.053	.071
Std. Dev.	*[e]	*	*	*	.023	.025	.090	.028	.045
Detection Limit	.02-1.0	.02-1.0	.077-.5	.077-.89	.02	.02	.02	.02	.02
Sample Size/# < DL	22/21	19/18	20/20	20/18	36/0	22/0	21/0	20/0	20/0
Data Category	C	C	C	C	A	A	A	A	A
ETHYLENE DIBROMIDE									
Ave. Conc. (ppt)	5-100	0-100	0-100	0-100	3-6	4-8	2-6	2-6	3-5
Std. Dev. (ppt)	*	*	*	*	4	9.0	2.0	1.4	1.0
Detection Limit (ppt)	100	100	100	100	5	5	5	5	5
Sample Size/# < DL	22/21	19/19	20/20	20/20	36/26	22/15	21/14	20/16	20/9
Data Category	C	C	C	C	B	B	B	B	B
ETHYLENE DICHLORIDE									
Ave. Conc.	0-17	0-14	0-18	1.0-18					
Std. Dev.	*	*	*	*					
Detection Limit	2.1-28	4.0-28	4.0-28	4.0-28					
Sample Size/# < DL	22/22	19/19	20/20	20/19					
Data Category	C	C	C	C					

TABLE V-1 (continued)

	SCAQMD				ARB				
Pollutant	**Anaheim**	**Azusa**	**Burbank**	**Lennox**	**El Monte**	**Long Beach**	**LA**	**Rubidoux**	**Upland**
METHYLENE CHLORIDE									
Ave. Conc.					5.1	4.6-4.7	3.5	2.2-2.3	2.7-2.8
Std. Dev.					2.6	2.9	2.0	1.9	1.7
Detection Limit					.006	.006	.006	.006	.006
Sample Size/# < DL					36/0	22/1	21/0	20/4	20/3
Data Category					A	A	A	B	B
PERCHLOROETHYLENE									
Ave. Conc.	3.1	2.0	2.7	2.3	1.6	1.0	1.2	.45	.70
Std. Dev.	2.4	1.8	1.6	2.5	.86	.56	.91	.32	.45
Detection Limit	.2	.2	.2	.2	.01	.01	.01	.01	.01
Sample Size/# < DL	22/0	19/0	20/0	20/0	36/0	22/0	21/0	20/0	20/0
Data Category	A	A	A	A	A	A	A	A	A
TOLUENE									
Ave. Conc.	4.0-5.6	2.5-4.9	5.6-6.7	3.5-5.3					
Std. Dev.	2.9	2.3	3.0	4.2					
Detection Limit	3.0-6.0	3.0-7.0	5.0	.40-5.0					
Sample Size/# < DL	24/8	21/11	23/5	23/11					
Data Category	B	B	B	B					
1,1,1-TRICHLOROETHANE									
Ave. Conc.	2.3	2.6	3.3	2.5	7.1	3.0	2.4	1.1	1.6
Std. Dev.	1.4	1.7	1.7	1.5	4.7	2.1	2.6	.73	1.1
Detection Limit	.23	.23	.23	.23	.02	.02	.02	.02	.02
Sample Size/# < DL	22/0	19/0	20/0	20/0	36/0	22/0	21/0	20/0	20/0
Data Category	A	A	A	A	A	A	A	A	A
TRICHLOROETHYLENE									
Ave. Conc.	.23-.35	.16-.33	.30-.45	.20-.23	.40	.29	.34	.10	.37
Std. Dev.	.23	.26	.72	.22	.25	.20	.22	.06	.17
Detection Limit	.20-.90	.11-.90	.12-.22	.12-.15	.02	.02	.02	.02	.02
Sample Size/# < DL	22/7	19/8	20/7	20/15	36/0	22/0	21/0	20/0	20/0
Data Category	B	B	B	B	A	A	A	A	A
VINYL CHLORIDE									
Ave. Conc.	0-2.0	0-2.0	0-2.0	0-2.0					
Std. Dev.	*	*	*	*					
Detection Limit	2.0	2.0	2.0	2.0					
Sample Size/# < DL	24/24	21/21	24/24	24/23					
Data Category	C	C	C	C					

TABLE V-1 (continued)

	SCAQMD				ARB				
Pollutant	Anaheim	Azusa	Burbank	Lennox	El Monte	Long Beach	LA	Rubidoux	Upland
BENZO(A)PYRENE (from EPA monitoring network)									
Ave. Conc. (ng/m^3)	.75						.75		
Std. Dev.	.17						.0079		
Det. Lim. (ng/m^3)	.33						.33		
Sample Size/# < DL	21/0						18/0		
Data Category	A						A		

---

[a] Blanks indicate no data available. Ranges of arithmetic annual averages defined as follows: first estimate is the average assuming all sub-detection limit observations equal zero; second estimate is the average assuming all sub-detection limit observations are equal to the detection limit concentration.

Standard deviations were calculated using only the observations above detection limits; if more than 90 percent of the observations were below detection limits, standard deviations were not calculated.

[b] Detection limits for some SCAQMD-measured pollutants reported as range because limits changed from sample to sample depending on analytical conditions. See text for further explanation.

[c] "Sample Size/# < DL" = (the total number of samples taken over the year) / (total number of these samples with concentrations below minimum detectable limits).

[d] Data Category codes for SCAQMD and ARB data are defined as: A - Most of the data above detection limits (>90%), C - Very few of the data points are above detection limits (<10%), and B - Several data points fall above and below detection limits.

[e] * standard deviation not calculated for Data Category C.

TABLE V-2

1985 ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS OF VARIOUS TOXIC METALS IN THE SOUTH COAST AIR BASIN[a]

(concentration in ng/m^3)

	E P A		A R B						
Pollutant	Anaheim	Los Angeles	El Monte	Long Beach	Los Angeles	Pico Rivera	River-side	Rubi-doux	Upland
ARSENIC									
Ave. Conc.	0-6.7	5.1-6.8	2.7	2.2-2.3	2.2-2.3	3.4-3.5	2.0	1.7-2.0	1.8-2.0
Std. Dev.	*[b]	6.3	1.5	1.9	1.7	2.7	.95	1.3	1.1
Detection Limit	6.7	6.7	.4	.4	.4	.4	.4	.4	.4
Sample Size/# < DL[c]	31/31	18/10	15/0	58/3	57/2	57/1	29/0	31/10	57/8
Data Category[d]	C	B	A	A	A	A	A	B	B
BARIUM									
Ave. Conc.	0-110	0-110							
Std. Dev.	*	*							
Detection Limit	110	110							
Sample Size/# < DL	27/27	23/22							
Data Category	C	C							
BERYLLIUM									
Ave. Conc.	0-.0016	0-.0016	0-.20	.007-.28	.008-.26	.000-.28	.046	0-.50	.014-.28
Std. Dev.	*	*	*	.006	.007	.011	.03	*	.018
Detection Limit[e]	.0016	.0016	.5-.02	.5-.02	.5-.02	.5-.02	.5-.02	.5-.02	.5-.02
Sample Size/# < DL	27/27	23/23	15/15	58/40	57/30	57/37	29/0	31/31	57/35
Data Category	C	C	C	B	B	B	A	C	B
CADMIUM									
Ave. Conc.	0-1.0	2.0-2.2	4.1	.73-1.1	1.9-2.2	1.1-1.5	.86-.87	.16-1.0	.73-1.1
Std. Dev.	*	2.0	2.0	.50	2.7	1.4	.51	.50	.55
Detection Limit	1.0	1.0	.3	.3	.3	.3	.3	.3	.3
Sample Size/# < DL	27/26	23/5	15/0	58/23	57/17	57/20	29/1	31/27	57/21
Data Category	C	B	A	B	B	B	A	B	B
CHROMIUM									
Ave. Conc.	1.8-5.1	10-11		4.7	7.0	5.0		2.5	2.2
Std. Dev.	1.2	5.0		1.8	2.6	1.5		1.8	1.3
Detection Limit	4.5	4.5		1.0	1.0	1.0		1.0	1.0
Sample Size/# < DL	31/15	18/2		31/0	31/0	31/0		31/0	30/0
Data Category	B	B		A	A	A		A	A
COBALT									
Ave. Conc.	1.1	1.0							
Std. Dev.	.70	.40							
Detection Limit	.37	.37							
Sample Size/# < DL	21/0	18/0							
Data Category	A	A							
COPPER									
Ave. Conc.	170	180							
Std. Dev.	71	46							
Detection Limit	4.8	4.8							
Sample Size/# < DL	37/0	23/0							
Data Category	A	A							

TABLE V-2 (continued)

Pollutant	E P A		A R B						
	Anaheim	Los Angeles	El Monte	Long Beach	Los Angeles	Pico Rivera	Riverside	Rubidoux	Upland
IRON									
Ave. Conc.	1300	1800							
Std. Dev.	680	700							
Detection Limit	22	22							
Sample Size/# < DL	27/0	23/0							
Data Category	A	A							
LEAD									
Ave. Conc.	180	280							
Std. Dev.	82	140							
Detection Limit	8.8	8.8							
Sample Size/# < DL	27/0	23/0							
Data Category	A	A							
MANGANESE									
Ave. Conc.	33	44		25	25	26		43	27
Std. Dev.	15	17		16	17	17		31	17
Detection Limit	3.6	3.6		1.0	1.0	1.0		1.0	1.0
Sample Size/# < DL	27/0	23/0		30/0	29/0	31/0		29/0	30/0
Data Category	A	A		A	A	A		A	A
MOLYBDENUM									
Ave. Conc.	1.9	2.7							
Std. Dev.	.5	1.3							
Detection Limit	1.5	1.5							
Sample Size/# < DL	27/0	23/0							
Data Category	A	A							
NICKEL									
Ave. Conc.	3.7-7.2	7.3-8.0		8.7	7.2	7.8		8.5	7.2
Std. Dev.	1.2	2.8		2.8	2.2	3.0		3.0	1.9
Detection Limit	5.9	5.9		1.0	1.0	1.0		1.0	1.0
Sample Size/# < DL	27/16	23/6		30/0	29/0	31/0		29/0	30/0
Data Category	B	B		A	A	A		A	A
VANADIUM									
Ave. Conc.	4.7,7.9	4.3-7.5							
Std. Dev.	1.5	1.7							
Detection Limit	6.2	6.2							
Sample Size/# < DL	27/14	23/12							
Data Category	B	B							
ZINC									
Ave. Conc.	37-100	230-240							
Std. Dev.	17	300							
Detection Limit	93	93							
Sample Size/# < DL	27/19	23/4							
Data Category	B	B							

---

[a] Blanks indicate no data available. Ranges of arithmetic annual averages defined as follows: first estimate is the average assuming all sub-detection limit observations equal zero; second estimate is the average assuming all sub-detection limit observations are equal to the detection limit concentration.

Standard deviations were calculated using only the observations above detection limits; if more than 90 percent of the observations were below detection limits, standard deviations were not calculated.

[b] * standard deviation not calculated for Data Category C.

[c] "Sample Size/# < DL" = (the total number of samples taken over the year) / (total number of these samples with concentrations below minimum detectable limits).

[d] Data Category codes for EPA and CARB data are defined as: A - Most of the data above detection limits (>90%), C - Very few of the data points are above detection limits (<10%), and B - Several data points fall above and below detection limits.

[e] Detection limits for beryllium changed from 0.5 to 0.02 ug/m^3 after July 1.

V.1.2 Population-Weighted Annual Average Ambient Concentrations

For purpose of calculating cancer risk using ambient air quality data, the basinwide population-weighted annual average concentration for each pollutant was estimated as follows. First, each station was spatially located with UTM coordinates and plotted onto a gridded map of the Basin. Average concentrations for each individual grid cell were interpolated based on their proximity to surrounding monitoring stations. This was done by weighting concentration data from each station by $1/R_i^2$, where R_i is the distance of monitoring station i from the particular grid cell, and then calculating the average over all stations. Therefore, stations farther away from a grid cell have less influence on the estimated grid cell average compared to those that are closer.

Finally, gridded population data for 1985, obtained from the ARB, were superimposed over the gridded concentration data. Basinwide population-weighted averages were calculated by summing the products of the population and concentration for each grid cell and then dividing by the total Basin population. Low and high averages were estimated for pollutants that were observed at sub-detection limit concentrations.

Table V-3 is a list of population weighted annual average concentrations for selected organic gases and metal pollutants for 1985. The following important factors must be noted before proper interpretation of these estimates can be made. First, pollutants that were measured at only a few stations were not included on this list because it would not be appropriate to calculate a basinwide average from only a few data points. Second, weighted averages appearing in the list should be used with caution because of questions regarding the sampling and analytical comparability of data from different monitoring networks. Ethylene dibromide and beryllium are two examples where caution should be used because of the wide range of concentrations observed by the respective monitoring networks. Also, averages for these two compounds, plus vinyl chloride, ethylene dichloride, arsenic, and cadmium, should be interpreted carefully because the majority of the observations were below detection limits.

The only way to ensure truly accurate and precise results from an analysis using combined data bases is to require that all monitoring networks conform to the same sampling, analytical, and quality assurance and control procedures. Although such requirement is not currently possible, these estimates provide a reasonable approximation of basinwide annual average ambient concentrations.

V.2 LITERATURE SURVEY OF AMBIENT DATA

A literature survey was conducted as a secondary source of information for estimating the impact of pollutants considered significant but for which Basin-specific monitoring and emissions data are not yet

TABLE V-3

POPULATION-WEIGHTED ANNUAL AVERAGE AMBIENT CONCENTRATIONS AND INDIVIDUAL CANCER RISKS IN THE SOUTH COAST AIR BASIN[a]

Pollutant	Unit[b] Risk Factor $(ug/m^3)^{-1}$	1985 Population[c] Weighted Annual Average Ambient Concentration (ug/m^3)		Population[d] Weighted Lifetime Individual Risk		Reference
Organic Gases						
		SCAQMD	ARB	SCAQMD	ARB	
Benzene	$5.3x10^{-5}$	5.1-8.9	12	$(2.7-4.7)x10^{-4}$	$6.6x10^{-4}$	ARB/DOHS, 1984
Benzo(a)Pyrene	$3.3x10^{-3}$	$7.5x10^{-4}$ e		$2.5x10^{-6}$ e		EPA, 1984b
Carbon Tetrachloride	$1.5x10^{-5}$	$6.9x10^{-1}$	$6.3x10^{-1}$	$1.0x10^{-5}$	$9.4x10^{-6}$	EPA, 1984c
Chloroform	$2.3x10^{-5}$	* f	$3.8x10^{-1}$	*	$8.7x10^{-6}$	EPA, 1985d
Ethylene Dibromide	$7.2x10^{-5}$	*	$(2.1-4.8)x10^{-2}$	*	$(1.5-3.5)x10^{-6}$	ARB/DOHS, 1985a
Methylene Chloride	$4.1x10^{-6}$		13-13		$(5.3-5.4)x10^{-5}$	EPA, 1985e
Perchloroethylene	$5.8x10^{-7}$	17	6.8	$9.8x10^{-6}$	$3.9x10^{-6}$	EPA, 1985g
Trichloroethylene	$1.3x10^{-6}$	1.2-1.8	1.7	$(1.5-2.4)x10^{-6}$	$2.2x10^{-6}$	EPA, 1985c
Trace Metals						
		EPA	ARB	EPA	ARB	
Arsenic (inorganic)	$4.3x10^{-3}$	$(2.7-7.6)x10^{-3}$	$(2.3-2.4)x10^{-3}$	$(1.2-3.3)x10^{-5}$	$(.99-1.0)x10^{-5}$	EPA, 1984a
Beryllium	$2.4x10^{-3}$	*	$(.11-2.6)x10^{-4}$	*	$(.26-6.2)x10^{-7}$	EPA, 1986a
Cadmium	$1.8x10^{-3}$	$(1.1-1.6)x10^{-3}$	$(1.4-1.8)x10^{-3}$	$(2.0-2.9)x10^{-6}$	$(2.5-3.2)x10^{-6}$	EPA, 1985b
Chromium	$1.5x10^{-1}$ g	$(6.3-8.1)x10^{-3}$	$4.8x10^{-3}$	$(.94-1.2)x10^{-3}$	$7.2x10^{-4}$	ARB/DOHS, 1985c
Nickel	$3.2x10^{-4}$ h	$(5.6-8.1)x10^{-3}$	$7.9x10^{-3}$	$(1.8-2.6)x10^{-6}$	$2.5x10^{-6}$	EPA, 1986b

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[a] Blanks indicate no data available. Population-weighted lifetime individual cancer risk estimates were calculated only for pollutants with a Data Category of A or B (see Tables III-1, III-2) and a published unit risk factor.

[b] Unit risk factor represents carcinogenic risk for a person breathing 1 ug/m^3 of a pollutant over a 70-year lifetime.

[c] Ranges of population-weighted averages are defined as follows: first estimate is the average assuming all sub-detection limit observations are equal to zero; second estimate is the average assuming all sub-detection limit observations are equal to the detection limit concentration.

Population-weighted averages for organic gases, were converted from ppbv units to ug/m^3 assuming standard conditions (temp. = 25°C and pressure = 1 atmosphere).

[d] A risk of $1.0x10^{-6}$ means that an individual has a one in a million chance of contracting cancer. Reader should understand that these values are probably accompanied by significant, but unquantified, uncertainty.

[e] Data for benzo(a)pyrene obtained from EPA monitoring stations.

[f] * indicates that the pollutant possessed a Data Category code of C and was, therefore, excluded. Pollutants assigned Data Category C were those in which less than 10 percent of the observations were above detection limits.

[g] Unit risk factor for hexavalent chromium; it is not known what fraction of the annual average concentration is chromium (VI).

[h] The potency of nickel varies by species; unit risk factor represents subsulfide species.

available. The types of data derived from a literature survey include short-term (less than one year) ambient data in the Basin and monitoring data collected in other major urban areas.

A number of short-term studies to measure ambient formaldehyde have been conducted in the Basin over the past several years. Table V-4 presents a summary of several representative studies referencing nine specific monitoring projects in this Basin with up to three hundred samples collected and analyzed. Formaldehyde concentrations appear to be somewhat higher inland compared to coastal areas, although the statistical significance of this relatively weak trend cannot be verified with these data because sampling dates, methods, and analytical procedures vary.

Diurnal and seasonal concentration patterns have been reported by a few investigators. Grosjean (1982) found that formaldehyde concentrations peaked in late afternoon and dipped to a minimum during the early morning hours. On a seasonal basis, Salas and Singh (1986) found that at one site in the Basin (Downey), concentrations appeared to be somewhat lower in the winter months compared to other times of the year.

Formaldehyde is emitted directly into the atmosphere from mobile and stationary sources and indirectly through photochemical formation. Grosjean, et al. (1983) suggested that formaldehyde concentrations nearer to the coast are influenced primarily by direct emission sources; whereas, inland concentrations are largely due to secondary photochemical formation processes in the atmosphere. The investigators estimated that at Azusa and Claremont, photochemical formation accounted for, on average, 44 and 78 percent, respectively, of the observed formaldehyde concentration relative to the Lennox site which was fixed at zero percent. Lennox was chosen as the reference because it was assumed to represent a site dominated by direct source emissions.

There are currently no available data on ambient concentrations of chlorinated dioxins and dibenzofurans in the Basin (ARB and DOHS, 1986). Ambient particulate samples collected in St. Louis, Missouri, and Washington, D.C., had average concentrations of dioxins and furans of 200 ppb (Czuczwa and Hites, 1984). Octachlorodioxin accounted for almost 90 percent of the total dioxins and furans collected at each location. These data have limited usefulness because the vapor phase concertrations of these pollutants were not measured. In addition, these measurements may not be representative of background concentrations in the Basin. ARB is currently conducting a special monitoring study in the Basin to determine existing dioxin and furan concentrations.

For purposes of estimating exposure and risk, these ambient concentrations were assumed to be representative of those experienced on an annual average basis in the Basin. Since octachlorinated dioxin is thought to be relatively non-carcinogenic (ARB and DOHS, 1986), it was subtracted from the average concentration of total dioxins and furans.

TABLE V-4
AMBIENT FORMALDEHYDE CONCENTRATIONS IN THE SOUTH COAST AIR BASIN AS MEASURED BY VARIOUS INVESTIGATORS

Location	Date	Number of Samples	Concentration[a] (ppb)	Reference[b]
Riverside	Jul 8-10, 1980	18	19 ± 7.6 (41.0 max)	1
Downey	Feb 28-Mar 1, 1984	48	15.5 ± 11.9 (67.7 max)	1
Downtown Los Angeles	Sept 29-Nov 13, 1981	23	4 - 86	2
East Los Angeles	May 19-Jun 20, 1980	36	2 - 40	3
Claremont	Sept 19-Oct 8, 1980	70	3 - 48	3
Azusa	Jul 30-Oct 24, 1980	18	0.7 - 35.4 (15.5 ± 9.26)[c]	4
Lennox	Jul 30-Oct 24, 1980	18	0.5 - 39.6 (8.94 ± 9.68)[c]	4
Various So. Calif. Locations (mobile lab)	Jul 30-Oct 24, 1980	20	4.6 - 65.9 (45.0 ± 17.3)[c]	4
Lennox	Jan 13-19, 1983	9	7.3 - 18.2 (12.3 ± 3.51)	5
Pico Rivera	Jan 13-19, 1983	8	4.3 - 33.3 (13.6 ± 9.20)	5
Pico Rivera	May 26-Jun 16, 1983	12	2.0 - 17 (7.8 ± 4.15)	5
Azusa	May 26-Jun 16, 1983	12	5.6 - 23.3 (13.5 ± 4.80)	5
Riverside	Jul 2-12, 1980	not reported	10.4 - 41 (19 ± 7.6)	6

[a] Data presented either as ranges of concentration or mean ± standard deviation unless otherwise noted.

[b] References:
1 Salas and Singh (1986).
2 Grosjean and Fung (1984).
3 Grosjean (1982).
4 Grosjean et al. (1983).
5 Rogozen et al. (1984).
6 Singh et al. (1982).

[c] Mean and standard deviation values are derived from authors' data.

CHAPTER VI
MODEL APPLICATION AND RESULTS

The enhanced model SCREAM was applied to the Basin using the detailed emissions, meteorology, and population data bases previously described. Annual average concentrations predicted by the model and those obtained from monitoring data were combined with unit risk factors to characterize individual cancer risk. For pollutants already identified as toxic and listed for regulation under AB 1807, unit risk factors developed by DOHS pursuant to this legislation were used for risk calculations. To date, unit risk factors have been developed only for benzene and hexavalent chromium. EPA values were used in all other cases. The DOHS benzene and hexavalent chromium unit risk factors are approximately 7 and 12 times higher than EPA's values and represent upper-bound estimates of these substances' lifetime carcinogenic potencies.

VI.1 RISK CHARACTERIZATION

To characterize risk from existing sources, the two measures of risk were generated for each of the 20 pollutants with unit risk factors. The results are included in the Appendices. To illustrate these results, the risk characterization results for benzene are discussed in this section. Figure VI-1 displays the spatial distribution of model-predicted ambient concentrations of benzene in the Basin. The highest concentrations are located in the metropolitan Los Angeles area where population density is greatest. Mobile source and gasoline marketing dominate the benzene emissions in this area. These model-predicted concentrations compare well with ambient measurements as discussed in Section VI.3.

The spatial distribution of the benzene individual cancer risks are presented in Figure VI-2. The highest grid-cell average upper-bound individual lifetime cancer risks for benzene are greater than 1×10^{-3}. There may be receptors with higher individual risks than those shown.

Population risk is estimated by interpolating individual lifetime cancer risks with population data for the Basin. The upper-bound number of excess cancer cases associated with lifetime (70-year) exposure to model-predicted ambient concentrations of benzene are illustrated in Figure VI-3. The highest estimates are in the grid cells with both the highest population density and highest model-predicted ambient concentrations. Again, these estimates are based on upper-bound 95 percent confidence limit estimates of carcinogenic potency. The true risk values may be considerably lower than those estimated.

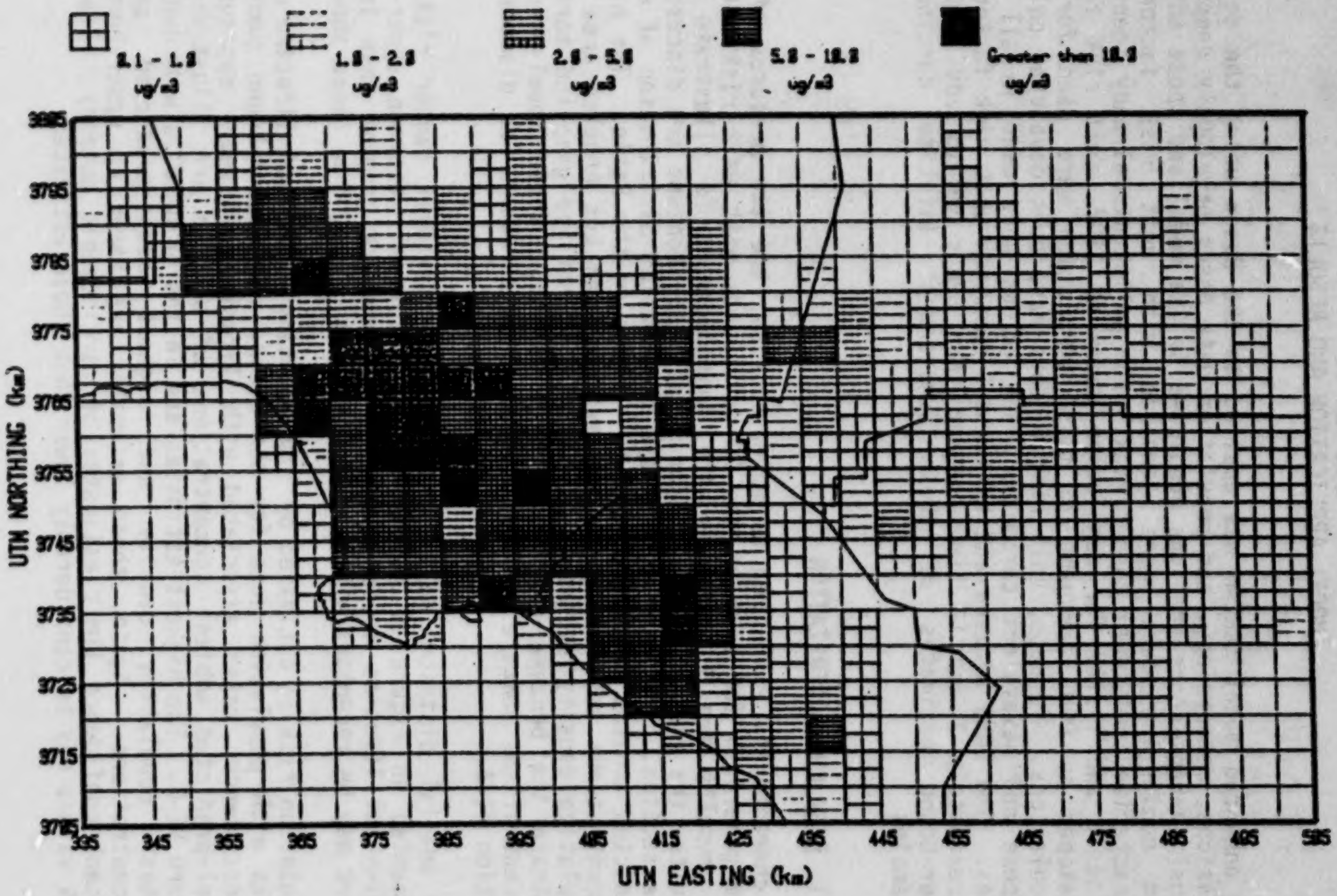
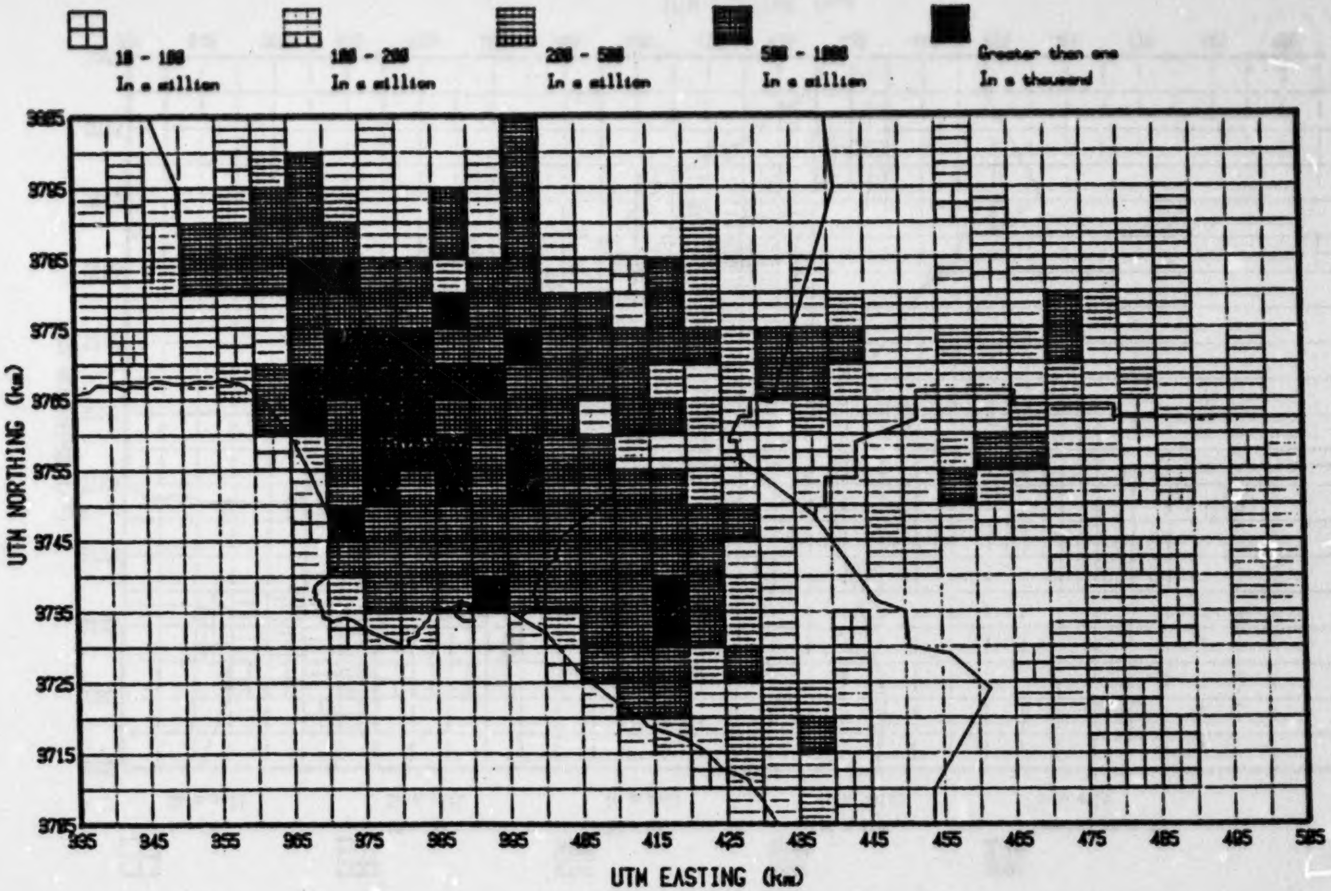

0.1 - 1.0 ug/m3
1.0 - 2.0 ug/m3
2.0 - 5.0 ug/m3
5.0 - 10.0 ug/m3
Greater than 10.0 ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE VI-1
MODEL PREDICTED ANNUAL AVERAGE BENZENE
CONCENTRATIONS IN THE SOUTH COAST AIR BASIN



10 - 100 In a million
100 - 200 In a million
200 - 500 In a million
500 - 1000 In a million
Greater than one In a thousand
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE VI-2

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT BENZENE IN THE SOUTH COAST AIR BASIN

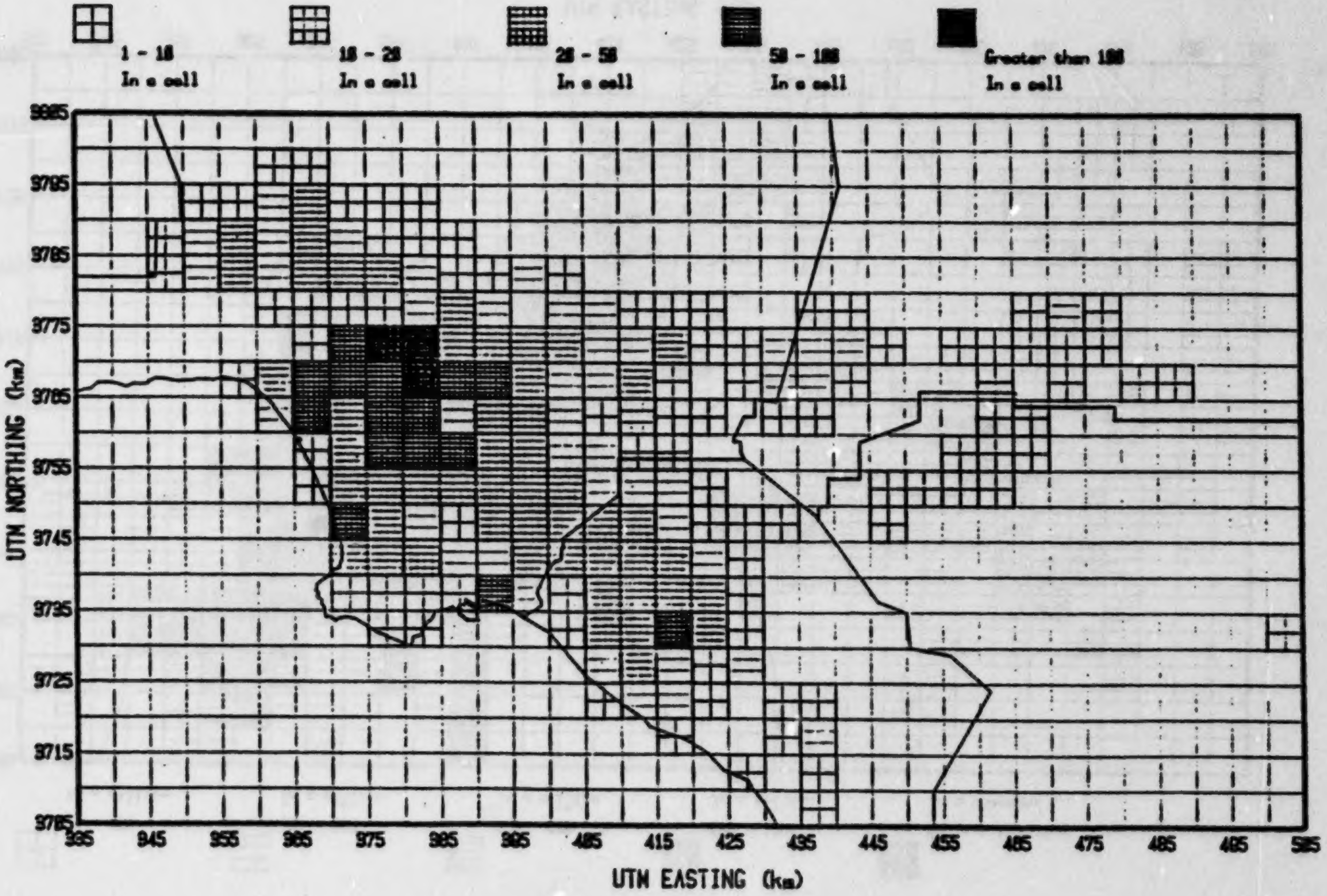

1 - 10
In a cell
10 - 20
In a cell
20 - 50
In a cell
50 - 100
In a cell
Greater than 100
In a cell
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE VI-3
MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED
WITH LIFETIME EXPOSURE TO BENZENE IN THE SOUTH COAST AIR BASIN

The spatial concentration patterns and the spatial distributions of individual and population cancer risks for the other potential carcinogens studied are presented in Appendix B and C, respectively. Also included and presented in Appendix C are the risk estimates for formaldehyde and dioxins based on ambient concentrations obtained from the literature.

This model can also generate data on the population-risk profile for the Basin. Figure VI-4 shows the number of people exposed to various risks from nine gaseous and trace metal species on a log-log scale. Population frequency distribution risk profiles are presented using both EPA and DOHS potency estimates for those substances for which DOHS has developed unit risk values. Almost the entire population in the Basin is exposed to ambient benzene concentrations corresponding to an upper-bound risk of 10^{-4} or higher; whereas, a small portion of the population is exposed to an upper-bound lifetime risk as high as 10^{-3}. Figure VI-4 illustrates the magnitude of risks and relative importance of the individual carcinogenic species. Of the nine species evaluated, ambient concentrations of benzene and hexavalent chromium appear to have the greatest impact on this Basin's population. These results are specific to this Basin because the estimated risks from benzene consider the existing control requirement of Phase I and Phase II vapor recovery for gasoline marketing. Risks and cancer cases would be higher in areas which do not employ these emissions controls.

VI.2 SOURCE APPORTIONMENT

The model can also be used to conduct source apportionment of excess cancer cases associated with each individual source category. Table VI-1 breaks down basinwide lifetime excess cancer cases for benzene and hexavalent chromium by mobile and stationary sources. Again, benzene cancer cases reflect the District's requirement for Phase I and Phase II vapor recovery for gasoline marketing.

Chromium emissions from mobile sources were assumed to be 10 percent hexavalent, while stationary sources were assumed to be 100 percent hexavalent. These assumptions are health protective yet plausible since stationary sources of chromium in the Basin are predominantly hard chrome platers.

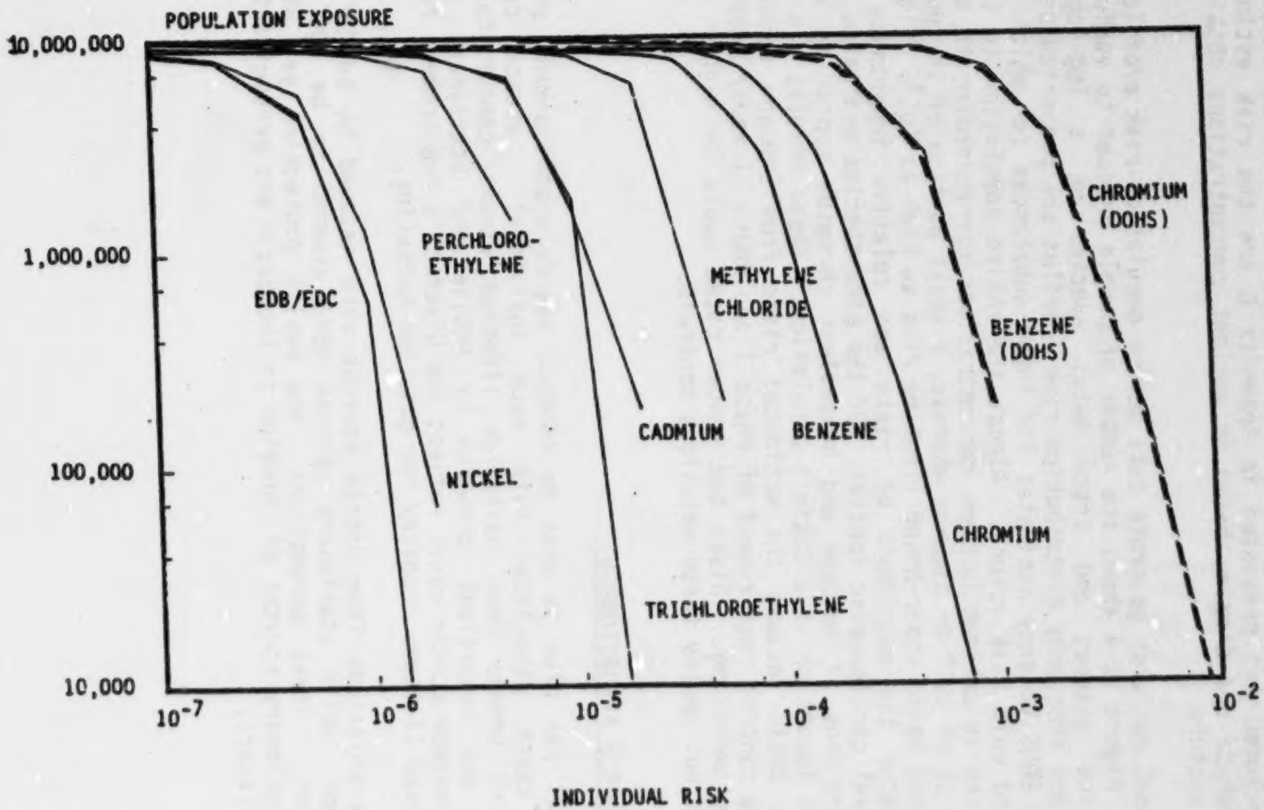


FIGURE VI-4

UPPER-BOUND MODEL PREDICTED POPULATION FREQUENCY DISTRIBUTION RISK PROFILE OF LIFETIME (70 YEAR) EXPOSURE TO NINE AMBIENT CARCINOGENS IN THE SOUTH COAST AIR BASIN (BASED ON UPPER-BOUND EPA —— AND DOHS - — - POTENCY VALUES)

TABLE VI-1
SOURCE APPORTIONMENT OF LIFETIME (70-YEAR) CANCER CASES FOR BENZENE AND HEXAVALENT CHROMIUM IN THE SOUTH COAST AIR BASIN

	BENZENE	HEXAVALENT CHROMIUM
MOBILE	248-2,110	85-1,020
STATIONARY	199-1,690	508-6,100
TOTAL	477-3,800	593-7,120

Source apportionment is an effective method of prioritizing allocation of resources to reduce risks. Table VI-1 indicates that stationary source emissions of hexavalent chromium should be considered a high priority for control.

Given sufficient data, a matrix of cancer risk from ambient carcinogens could be developed from model output. Figure VI-5 depicts a cancer case matrix for ambient carcinogens and source categories. This matrix contains estimates of the number of excess cancer cases from exposure to: (1) individual chemical species emitted from a single source category, (2) individual chemical species emitted from all source categories, and (3) all chemical species emitted from an individual source category. The total number of excess cancer cases for the whole region is also included in this matrix. Emissions data are not yet available to complete this matrix.

V1.3 COMPARISON OF MEASURED AND MODEL-PREDICTED AMBIENT CONCENTRATIONS AND RISKS

Annual average ambient concentrations obtained from monitoring data were compared with annual average model-predicted concentrations at the same receptors to identify problems in the modeling approach and the input data to the model. Table VI-2 compares the measured and model-predicted annual average concentrations in the Basin for both carcinogenic organic gases and metals. Also shown in this table are the range of ratios of the measured to model-predicted concentrations. The further the ratio is from one, the greater is the discrepancy between measured and modeled concentrations, indicating problems with model input data or assumptions.

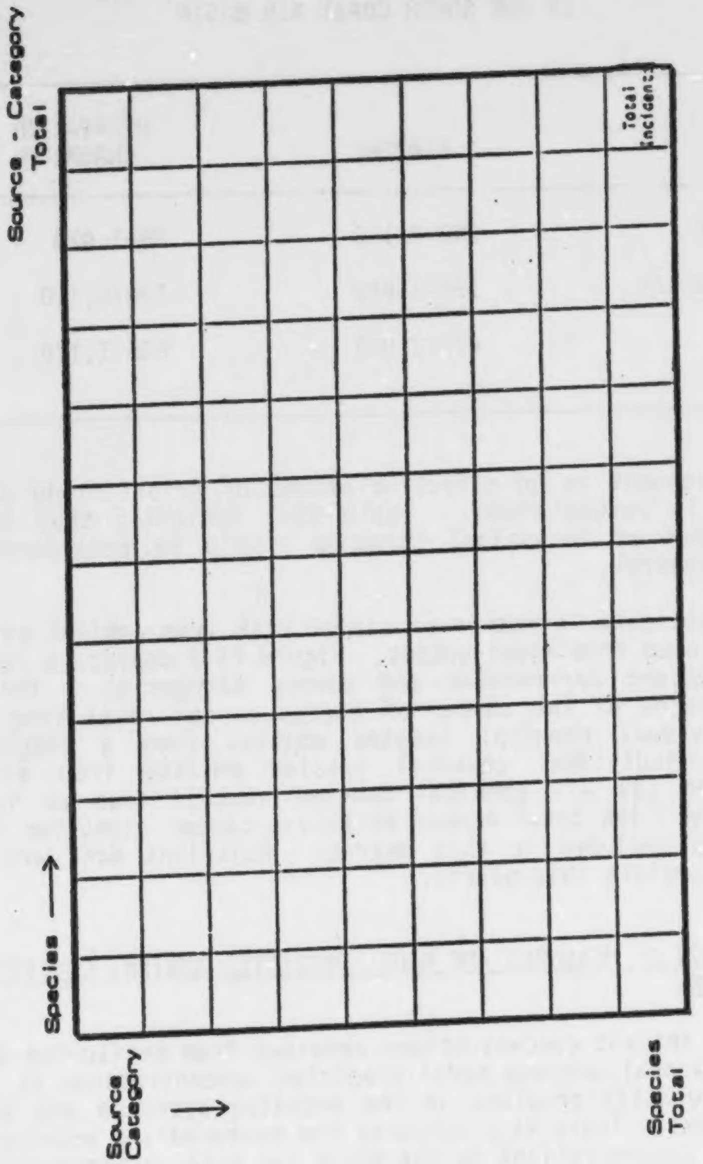

Species →
Source Category →
Source - Category Total
Species Total
Total Incidents

FIGURE VI-5

MATRIX OF CANCER RISK FROM AMBIENT CARCINOGENS

TABLE VI-2

COMPARISON OF MEASURED AND MODEL-PREDICTED TOXIC AIR POLLUTANTS

AIR TOXICS	MEASURED	MODEL-PREDICTED	PREDICTED/MEASURED RATIO
ORGANIC GASES (ppb)			
Benzene	1.0-4.9	0.56-5.0	0.22-1.8
Carbon Tetrachloride	0.10-0.12	$1.1\text{-}24 \times 10^{-5}$	$1.0\text{-}25 \times 10^{-4}$
Chloroform	0.02-0.30	$2.0\text{-}17 \times 10^{-8}$	$0.68\text{-}49 \times 10^{-7}$
Ethylene Dibromide	0-100	$1.1\text{-}22 \times 10^{-4}$	$0.11\text{-}110 \times 10^{-5}$
Ethylene Dichloride	0-18	$1.7\text{-}10 \times 10^{-3}$	$1.2\text{-}52 \times 10^{-4}$
Perchloroethylene	0.5-3.1	0.28-2.4	0.22-1.5
Toluene	2.5-6.7	0.80-3.7	0.16-0.66
Trichloroethylene	1.1-7.1	0.33-2.9	0.13-54
Vinyl Chloride	0-2.0	5.1×10^{-5}	2.6×10^{-5}
TRACE METALS (ng/m^3)			
Arsenic	0-8.8	$5.0\text{-}10 \times 10^{-4}$	$1.5\text{-}2.3 \times 10^{-4}$
Beryllium	0-0.5	$0\text{-}5.4 \times 10^{-3}$	0.003-3.4
Cadmium	0-4.1	1.1-9.6	0.71-1200
Chromium	1.8-11	3.6-60	1.06-8.6
Lead	180-280	1100-1700	3.9-9.4
Nickel	3.7-8.9	0.7-5.6	0.08-7.3

There is good agreement between the measured and model predicted concentrations for several organic gases and metals. Ratios for benzene, perchloroethylene, toluene, 1,1,1-trichloroethane, beryllium, cadmium, chromium, lead, and nickel are all very close to 1.0. These results give a great deal of confidence to the model-predicted concentrations. The ratios for carbon tetrachloride, chloroform, ethylene dibromide, ethylene dichloride, vinyl chloride, and arsenic range between 10^{-7} to 10^{-4} which indicates that ambient concentrations were under-predicted by the model.

The following may explain at least part of the discrepancies found. Carbon tetrachloride is extremely persistent in the atmosphere, with a half-life of approximately 40 years, and has globally accumulated in the ambient air. Thus, ambient concentrations are much greater than can be accounted for by present emissions data used as input to the model. Chloroform is thought to be emitted in large quantities from such non-traditional sources as swimming pools and sewage treatment plants. The District's toxics emissions data does not currently include these types of sources. Likewise, vinyl chloride emissions from landfills have not been adequately quantified and a default value of one pound per year was assumed for modeling purposes. The discrepancies between ethylene dibromide and ethylene dichloride ambient measurements and model predicted concentrations may be due to the increases in measured concentrations resulting from entrainment and out-gassing from the ground. Concentrations of arsenic were also predicted to be lower than measured results and may be a result of the contribution from soil dust or that other sources of arsenic emissions may not have been included in the emissions data.

Additional emissions inventory efforts may resolve many discrepancies between measured and model-predicted concentrations. The model's treatment of carbon tetrachloride's persistence in the ambient air could also be revised.

Estimates of the upper-bound lifetime number of cancer cases in the Basin based on the measured, model-predicted, and literature survey annual average concentrations are presented in Table VI-3. The differences in concentrations should be considered when comparing the three sets of cancer estimates. Since the model under-predicted ambient concentrations for several pollutants, the risk estimates based on measured concentrations may be more representative upper-bound estimates.

In either case, the relative risks of the different pollutants are easily discerned. Again, benzene and hexavalent chromium contribute the greatest number of cancer cases to the total estimate. In addition, existing ambient concentrations of formaldehyde may result in a relatively large number of excess cancer cases in the Basin. The relative importance of the other pollutants is apparent from Table VI-3.

TABLE VI-3

ESTIMATION OF LIFETIME (70 YEAR) UPPER-BOUND CANCER CASES ASSOCIATED WITH AMBIENT CARCINOGENS IN THE SOUTH COAST AIR BASIN

AIR TOXICS	DATA BASES		
	AMBIENT MEASURED	MODEL PREDICTED	LITERATURE
ORGANIC GASES			
Benzene	6930	3860	#
Carbon Tetrachloride	99	0.1	#
Chloroform	91	0	#
Dioxins and Furans	*	*	20-400
Ethylene Dibromide	26	0.5	#
Ethylene Dichloride	*	0.5	#
Formaldehyde	*	*	2000
Methylene Chloride	562	236	#
Perchloroethylene	41	30	#
Trichloroethylene	23	*	#
TRACE METALS			
Arsenic	105	0.01	#
Beryllium	6	0.02	#
Cadmium	34	67	#
Chromium	7560	7120	#
Nickel	26	6	#
TOTAL	15500	11320	

* No data available
# Basin-specific data not available

CHAPTER VII
ASSUMPTIONS AND UNCERTAINTIES

Many assumptions and uncertainties are associated with the quantification of cancer risk as a result of community exposure to routinely released toxic air pollutants. In deriving a value for the potency of a carcinogen (i.e., the unit risk factor) and applying that factor to calculated cancer impacts, the following assumptions, which inject a considerable degree of uncertainty into the analysis, are made:

- The response of humans to the substance is qualitatively and quantitatively the same as in test animals;
- The effects of the substance at a very high dose can accurately be extrapolated to a very low dose by mathematical models containing assumptions on the relation between dose and response;
- The routes of exposure do not affect the qualitative or quantitative results of the test;
- All of the substance which is inhaled is absorbed into the body; and
- An average person weighs 70 kg and breathes 20 m^3 of air per day.

As a result of these assumptions, unit risk factors are considered plausible, 95-percent, upper-bound estimates, i.e.; the risks are not likely to be higher, but could be considerably lower. However, for known human carcinogens, CAG usually presents a most likely estimate, not a 95-percent, upper-bound value. Because CAG has currently characterized only 55 substances as to their carcinogenic potency, risk estimates for most of the hundreds of chemicals present in urban ambient air cannot be calculated.

In addition, there are several assumptions which relate to the quantification of exposure and dose which can cause the risk analysis to either overestimate or underestimate the cancer impact. Risk assessments assume that people are exposed to the estimated concentrations for 70 years, 24-hours a day. This is an overestimate of the lifetime of most emission sources. In addition, most people change homes and move around during each day. Population growth estimates are also often not sufficient to quantify the 70-year exposed population for calculations of the number of excess cancer cases. However, these assumptions provide consistency in comparing relative risks between different sources and can be used to ensure that an individual source does not incur more than a standard amount of risk per unit of time.

At present, risk assessment methods for carcinogens in the ambient air assume that indoor concentrations are the same as outdoor. If outdoor concentrations do not penetrate completely indoors, then estimates of risk have been overstated since more time is spent indoors. Additionally, indoor sources of air pollutants are not addressed. Certain pollutants may be present indoors at much higher concentrations than outdoors and may make a significant contribution to the estimated risk associated with exposure to air pollutants.

Another assumption made is that all risks are additive, even though certain combinations of exposures may have synergistic (greater than additive) effects, antagonistic (less than additive), or other types of interactions.

There are risks that cannot yet be quantified using exposure models. These risks are from exposure to compounds formed in the atmosphere (e.g., formaldehyde). Literature data indicate that these risks may be significant. Other chemicals may be transformed to less potent species in the air (e.g., reduction of hexavalent chromium to trivalent chromium) and an overestimate of the risk would result.

While these assumptions and ensuing uncertainties must be considered in evaluating results of this type of assessment, it is currently the best available technique to estimate the magnitude of the risks and has been employed by many agencies for regulatory decisions. The assumptions used are intended to be health protective, yet have some bearing on reality.

CHAPTER VIII
CONCLUSIONS AND RECOMMENDATIONS

An urban air toxic exposure and risk assessment model has been developed and applied to the Basin. The technical approach for application of this model can be used:

- To determine the magnitude of areawide risks and excess cancer cases associated with toxic air pollutants emissions;
- To evaluate potential impacts of criteria pollutants control strategies on toxic air pollutants;
- To develop and prioritize a toxic air pollutants control program;
- To evaluate potential impacts of proposed new and modified sources of toxic air pollutants emissions.

The assumptions built into the model limit its application in interpreting the risk and excess cancer cases estimates. Some assumptions lead to a potential underestimation of the risk to the population, while others result in an upper-bound estimate of the cancer risk. An understanding of these assumptions is needed in evaluating the uncertainty associated with the estimated risks.

Even with the uncertainties in the modeling approach, the results can be used to indicate the relative importance of the individual carcinogenic species and the relative contribution of individual source categories to the total risk from a specific carcinogenic pollutant.

Results of this study show that of the carcinogenic pollutants evaluated, both measured and model-predicted ambient concentrations of benzene and hexavalent chromium have the greatest potential impact on the Basin's population. Calculations of risk based on literature data for ambient formaldehyde concentrations indicate a relatively significant potential impact in the Basin from this pollutant. The total number of lifetime excess cancer cases estimated from either ambient concentration data base is approximately 20 to 30 percent of the 50,000 lifetime cancer cases expected in the Basin if approximately two percent of all cancer cases are due to environmental pollution.

Recommendations for refining this methodology would include:

- Reduce the limitations of the model's application by enhancing the ability to treat population mobility, different microenvironment exposures, and multiple pathway exposures;
- Maintain and upgrade toxic emission inventory efforts on a routine basis to characterize all sources of selected toxic air

pollutants, including both permitted and non-permitted point sources, and motor vehicle sources;

- Develop analytical techniques for the sampling and analysis of selected ambient air toxics and for quantifying emissions from existing sources; and

- Maintain District's ambient monitoring networks for the selected gaseous organics and include ambient toxic metal compounds as well.

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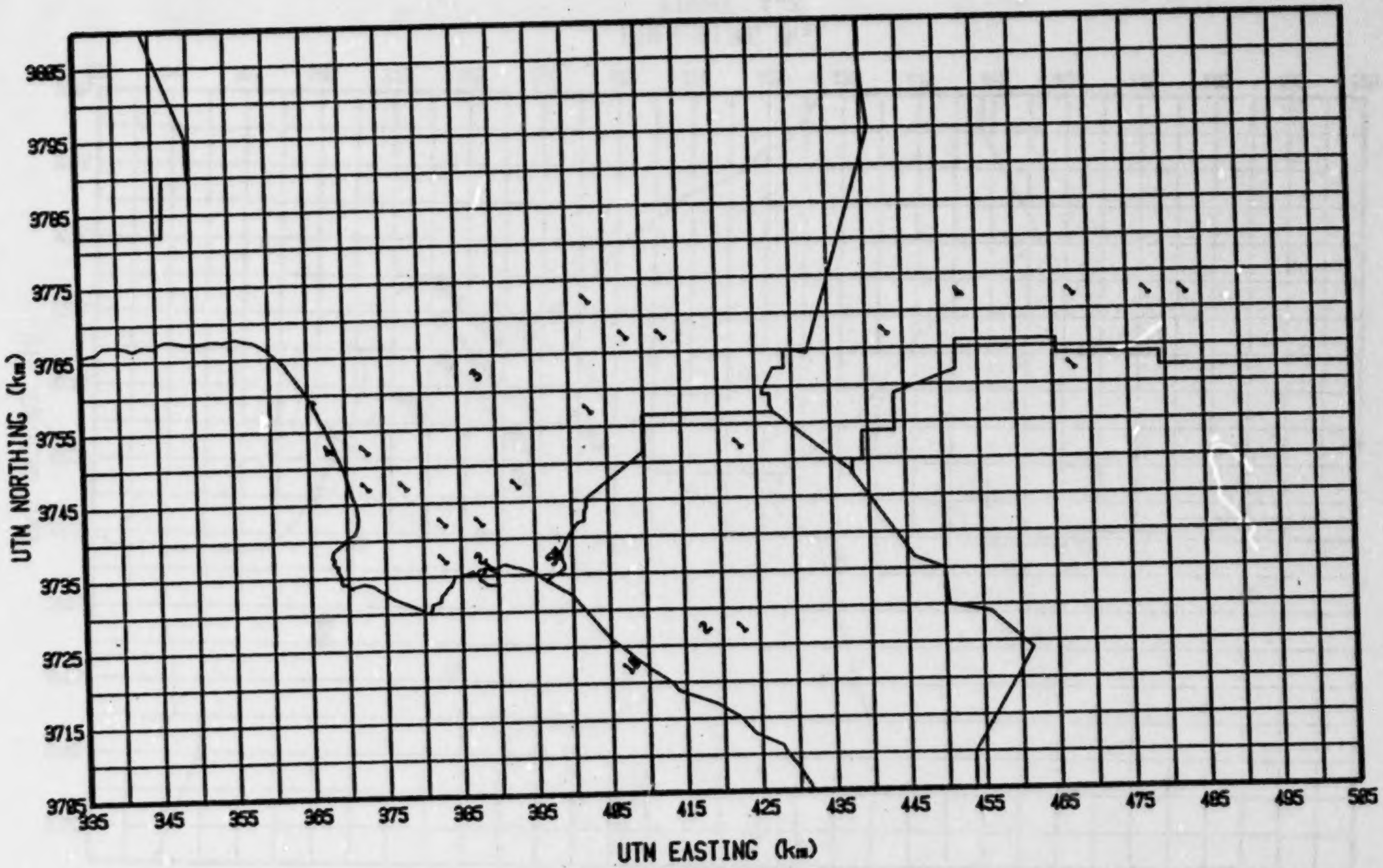
APPENDIX A

SPATIAL DISTRIBUTION OF POINT SOURCE AIR TOXICS EMISSIONS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3785
3775
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3755
3745
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UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
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495
505

FIGURE A-1

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF ARSENIC (lbs/yr)

Reproduced from
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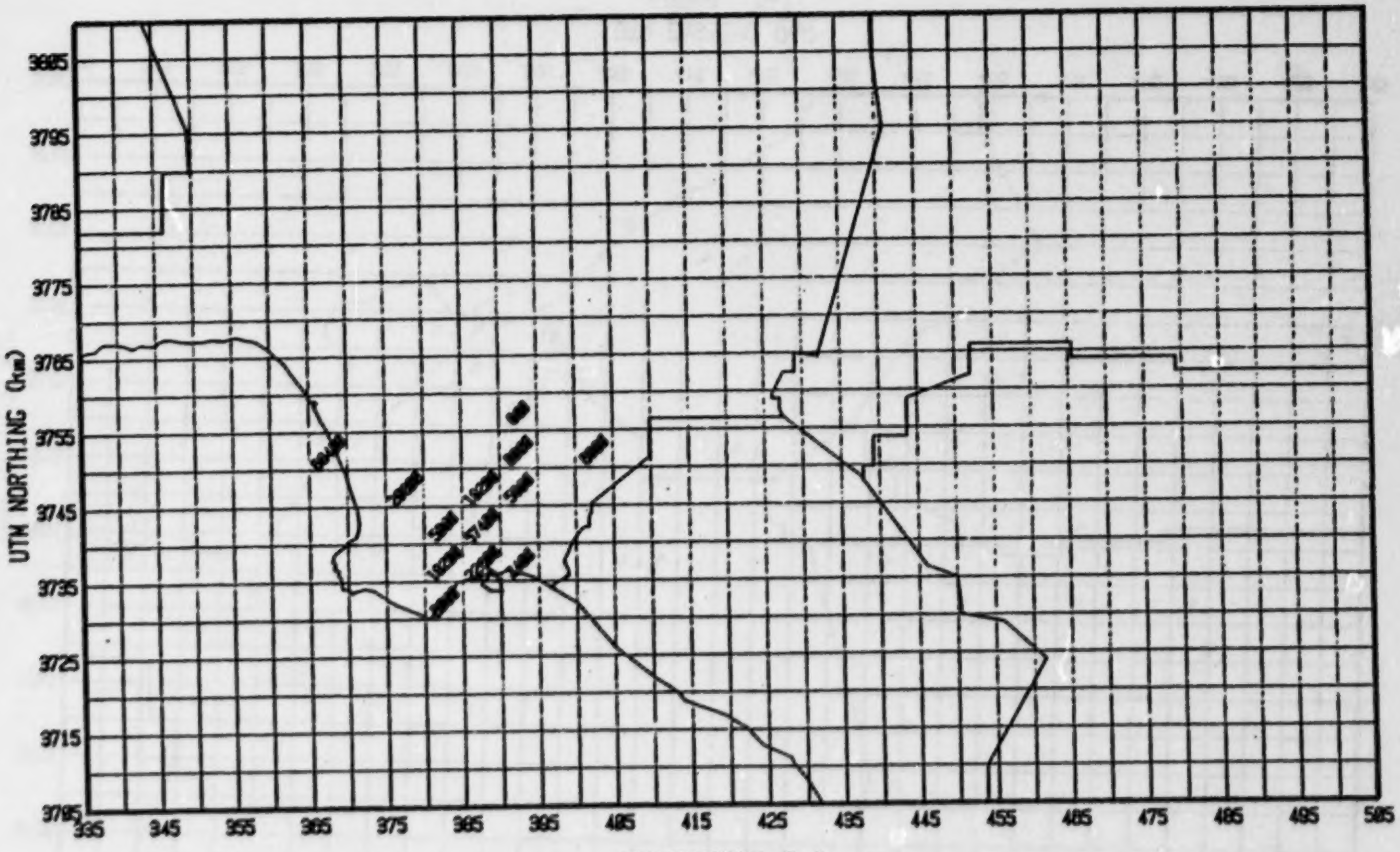
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UTM NORTHING (km)
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355
365
375
385
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405
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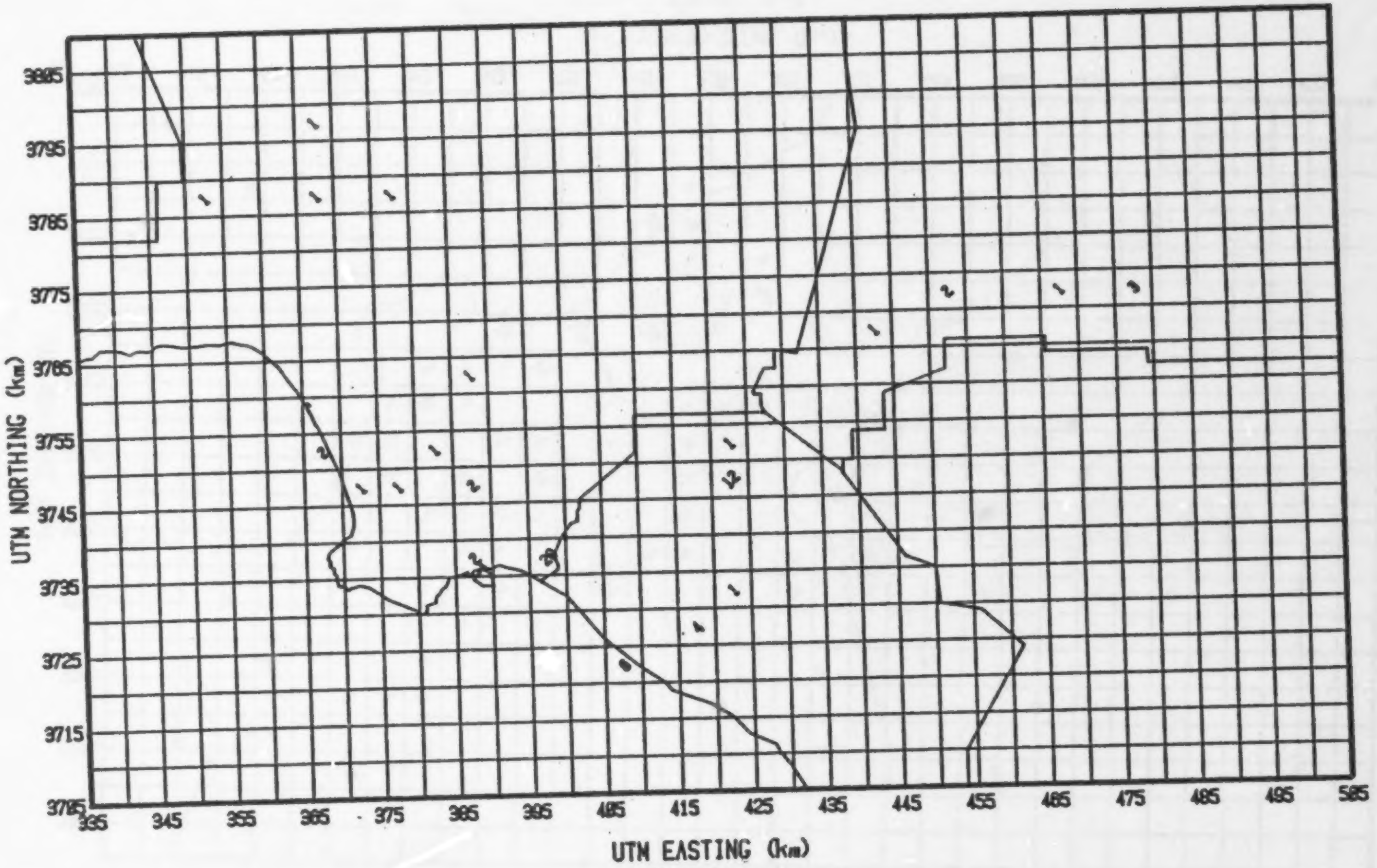
505
UTM EASTING (km)

FIGURE A-2

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF BENZENE (lbs/yr)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425
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445
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465
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485
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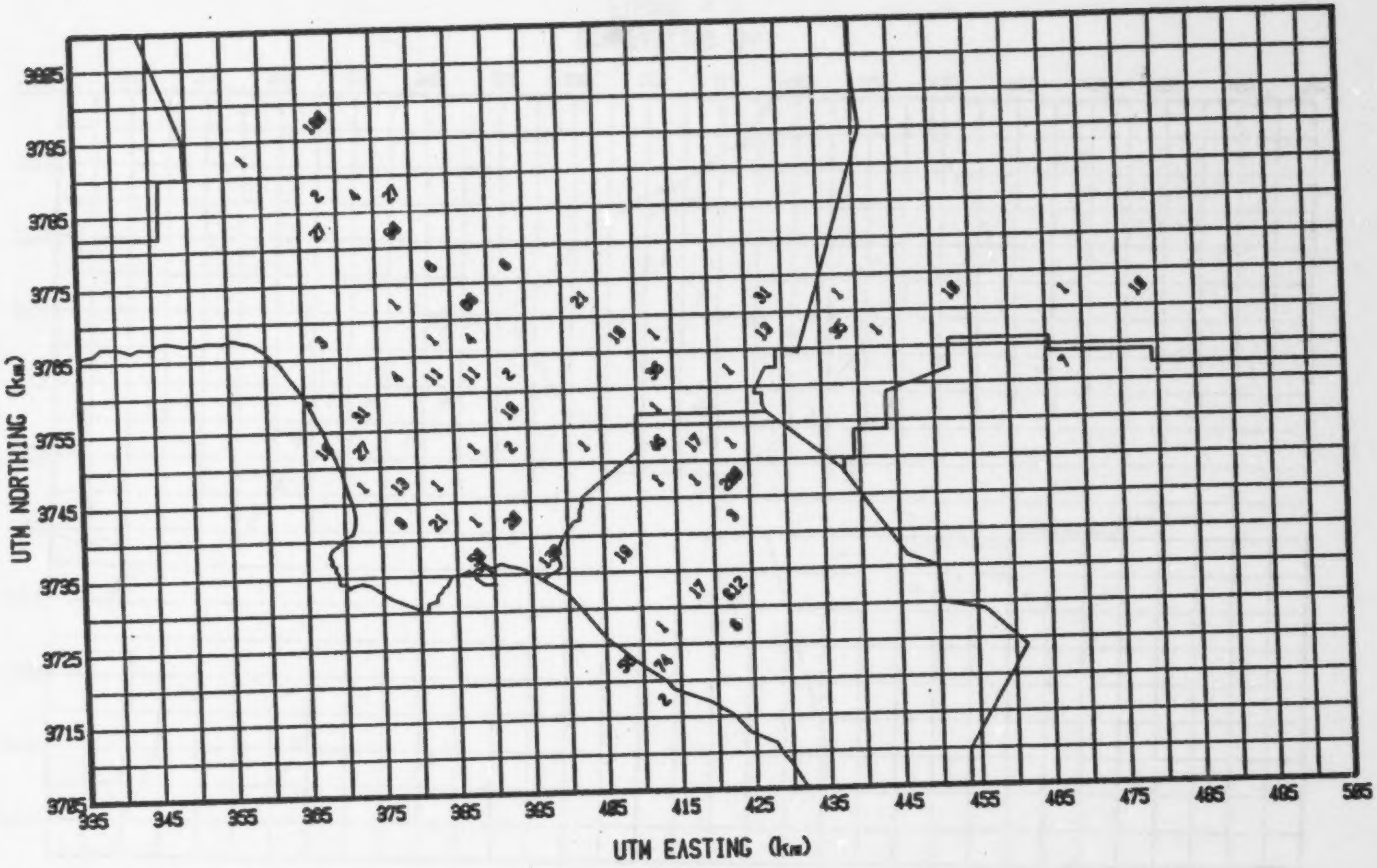
UTM EASTING (Km)

FIGURE A-3

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF BERYLLIUM lbs/yr)

Reproduced from
best available copy.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UTM EASTING (km)
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345
355
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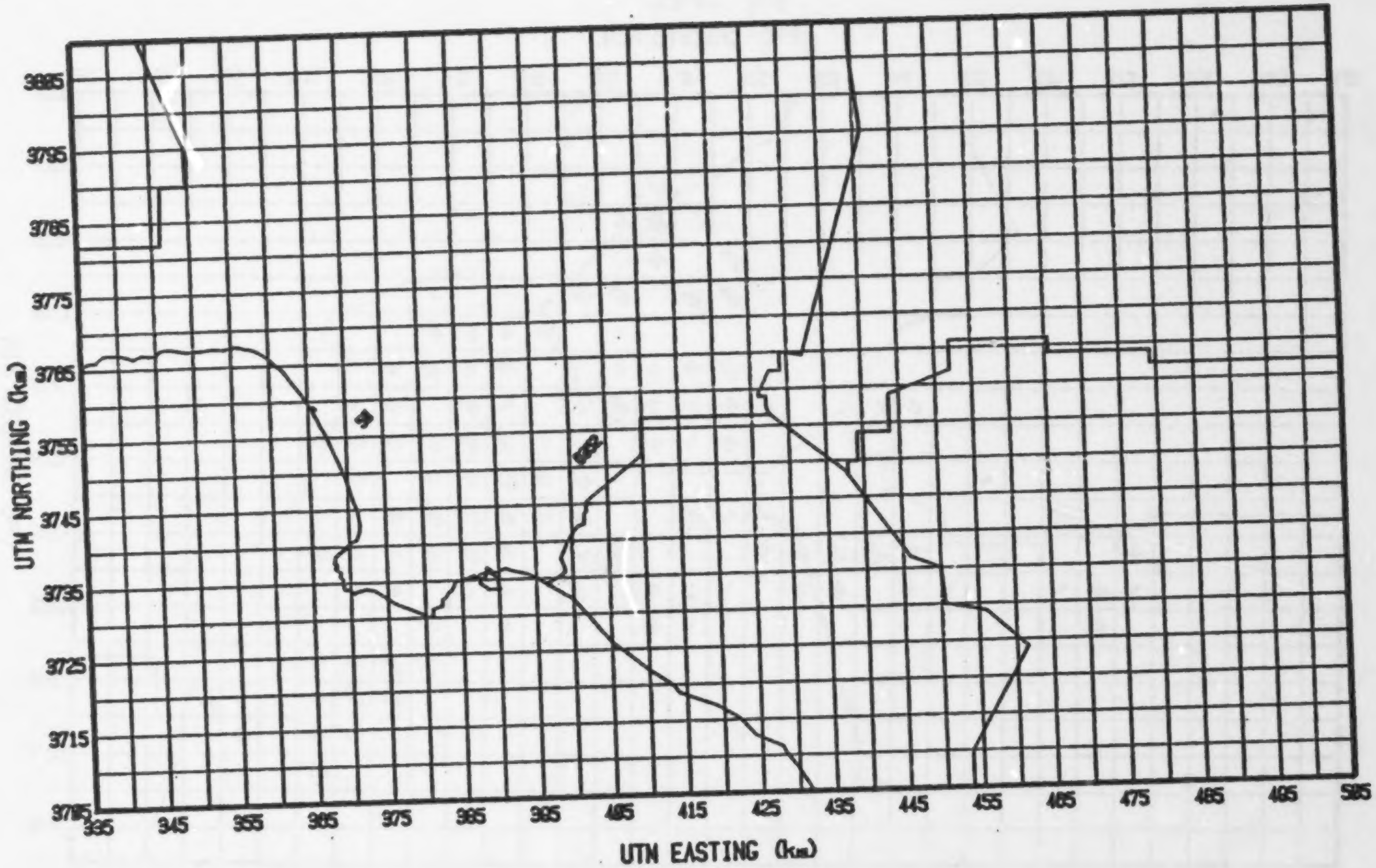
FIGURE A-4
SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF CADMIUM (lbs/yr)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UTM EASTING (km)
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365
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395
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482

FIGURE A-5

DISTRIBUTION OF POINT SOURCE EMISSIONS OF CARBON TETRACHLORIDE (lbs/yr)

Reproduced from
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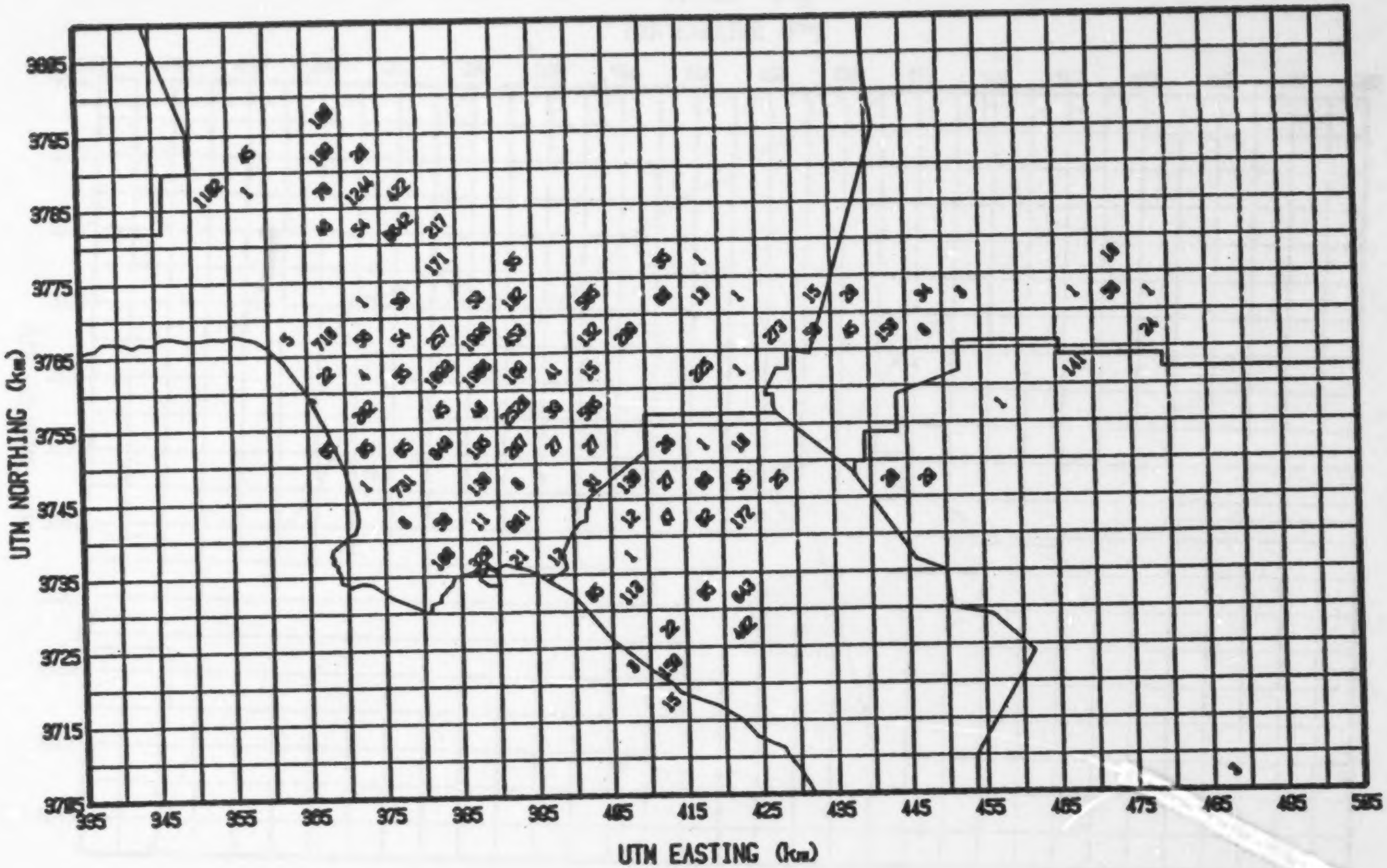
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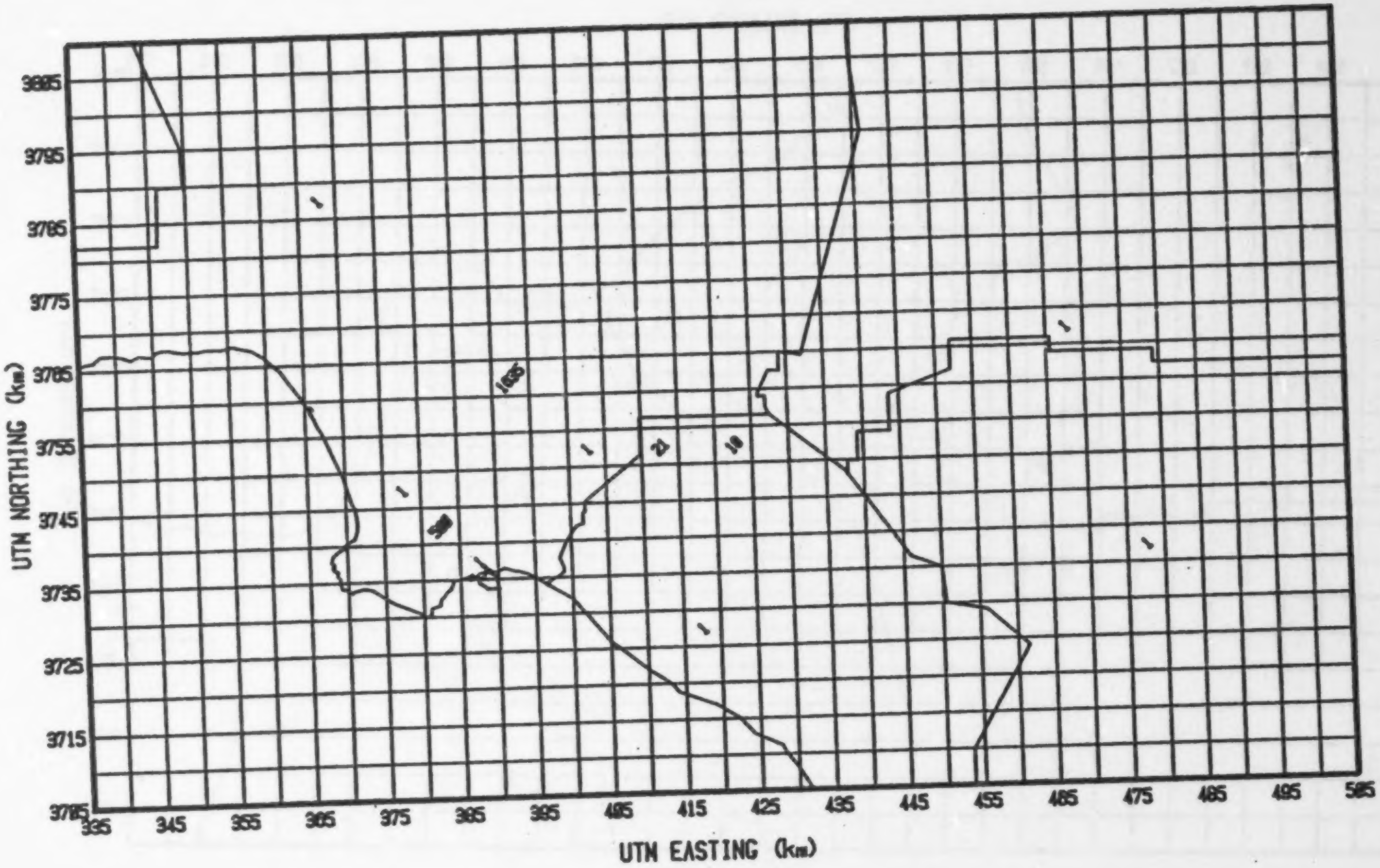
UTM EASTING (km)

FIGURE A-6

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF CHROMIUM (lbs/yr)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365
375
385
395
405
415
425
435
445
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UTM EASTING (km)
1
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1
10

FIGURE A-7

DISTRIBUTION OF POINT SOURCE EMISSIONS OF ETHYLENE DIBROMIDE (lbs/yr)

Reproduced from
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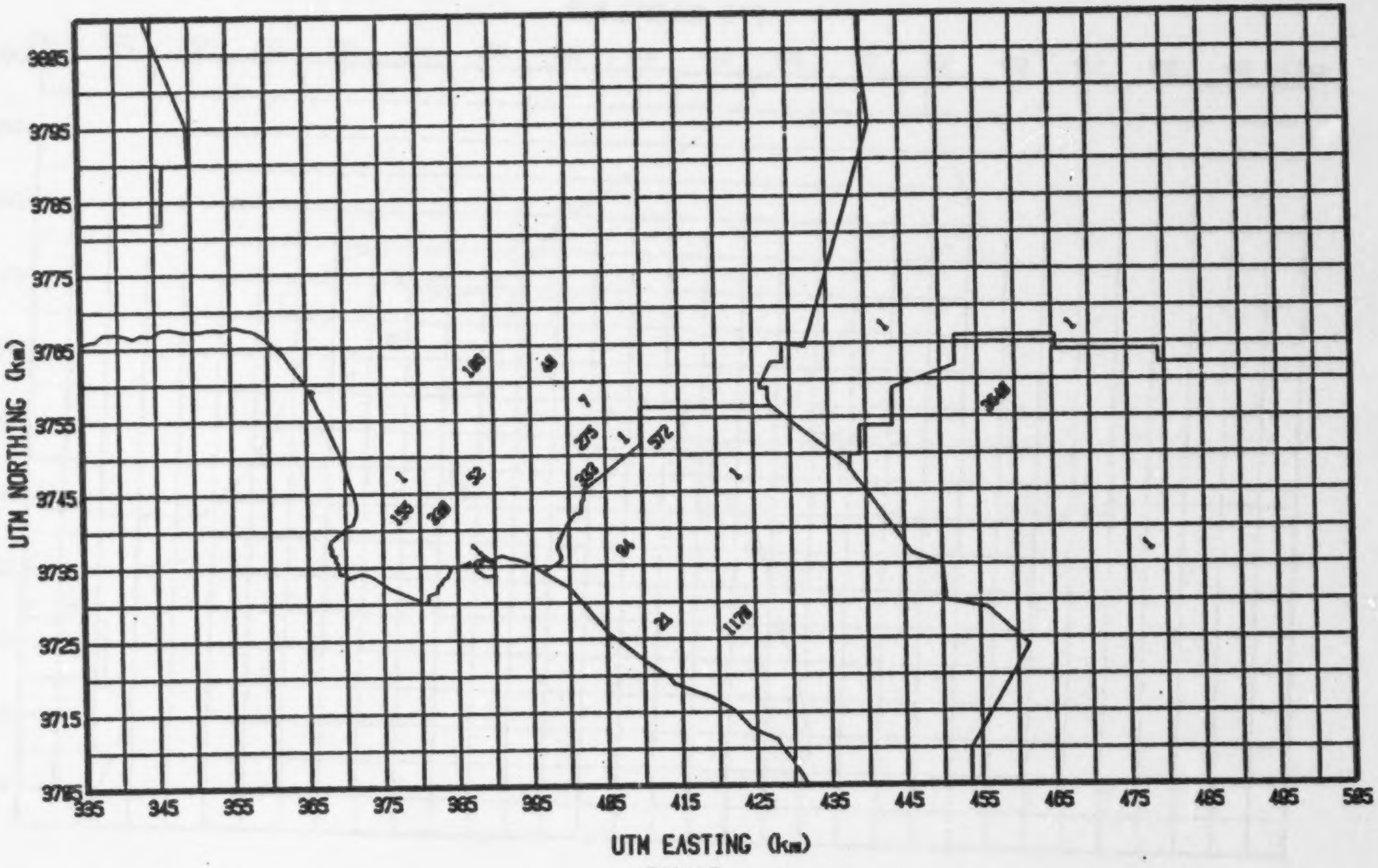
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UTM EASTING (km)
1
1
1
1
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1
42
572
1178

FIGURE A-8

DISTRIBUTION OF POINT SOURCE EMISSIONS OF ETHYLENE DICHLORIDE (lbs/yr)

Reproduced from
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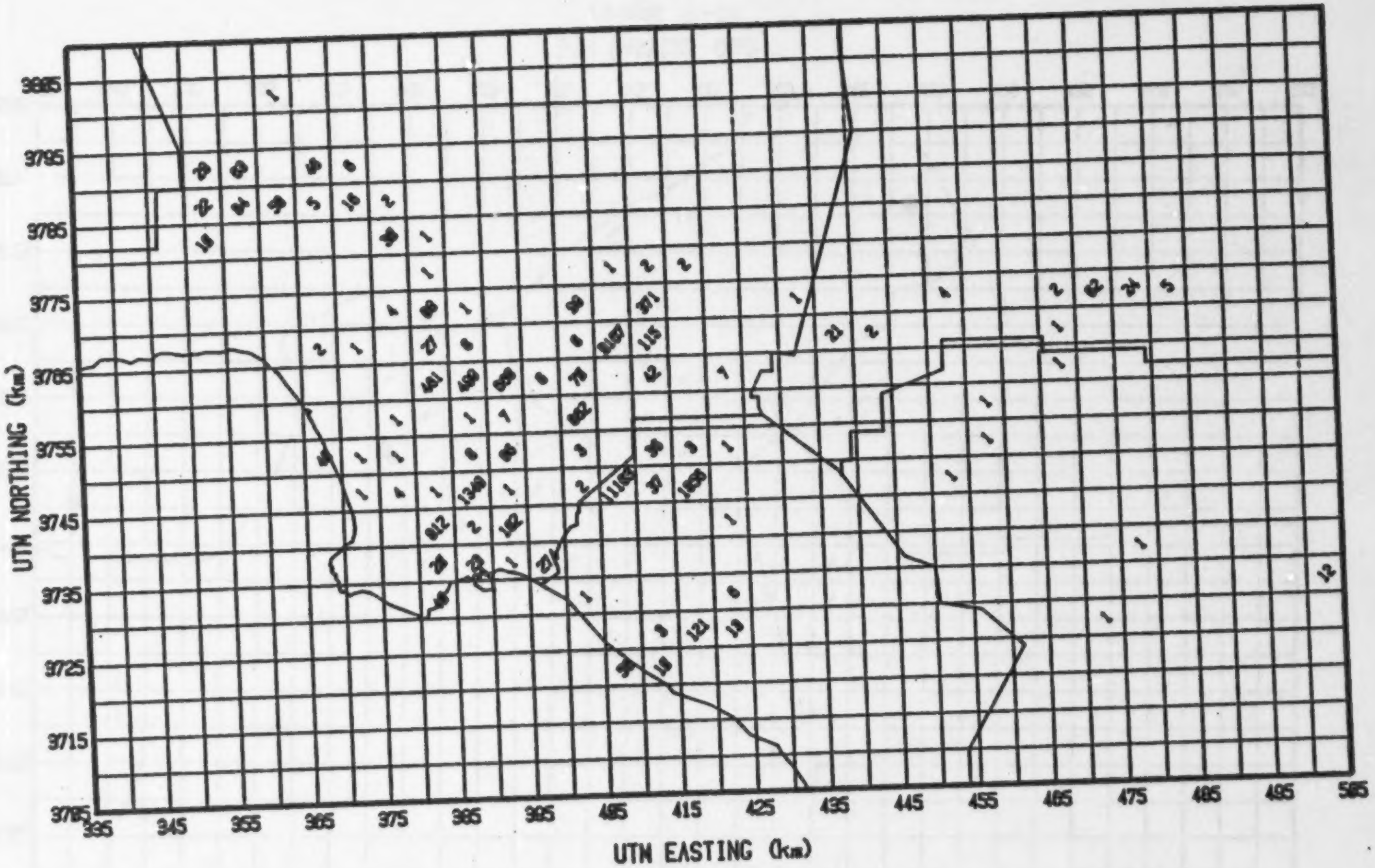
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UTM EASTING (km)
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345
355
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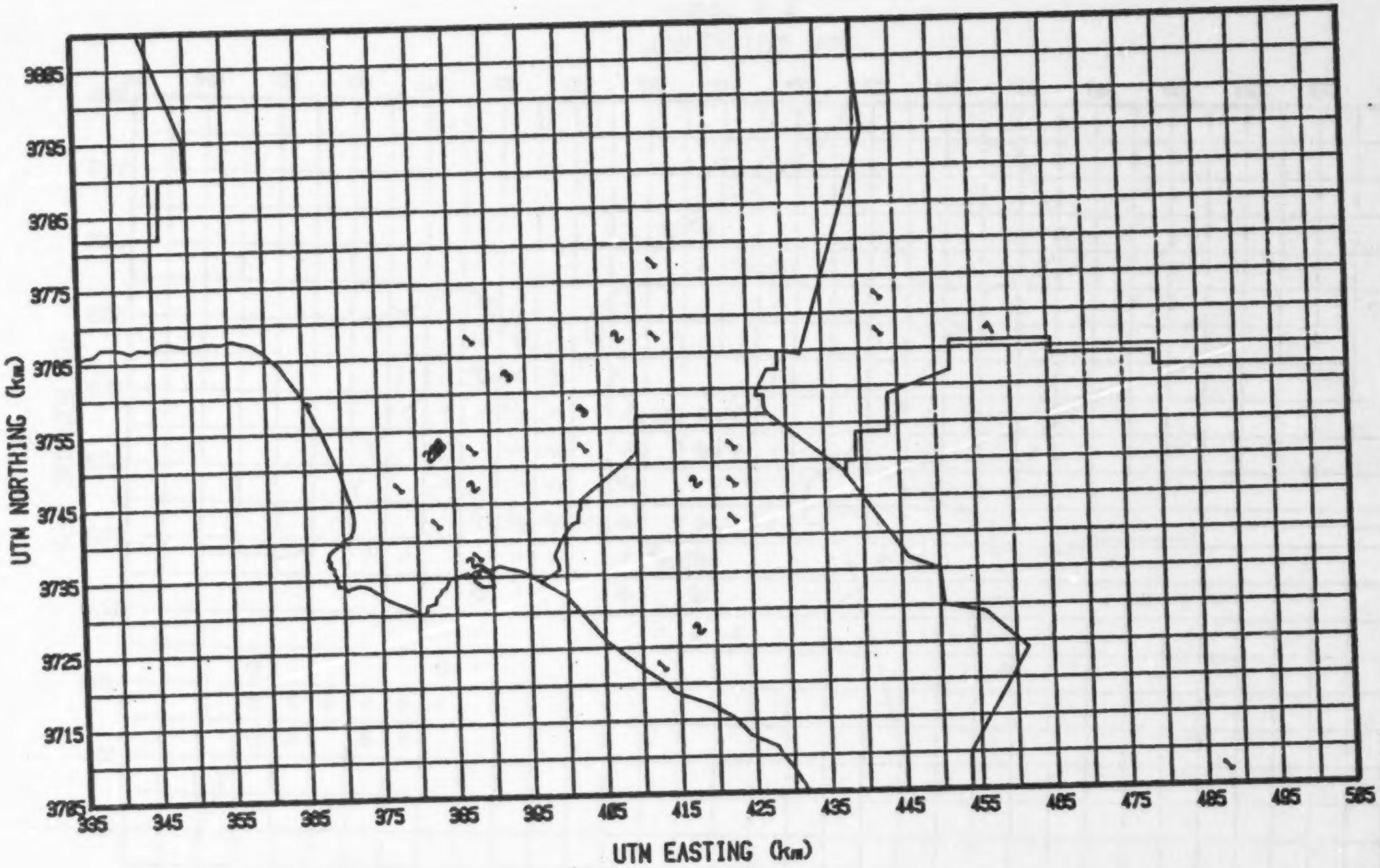
FIGURE A-9

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF LEAD (lbs/yr)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UTM EASTING (km)
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355
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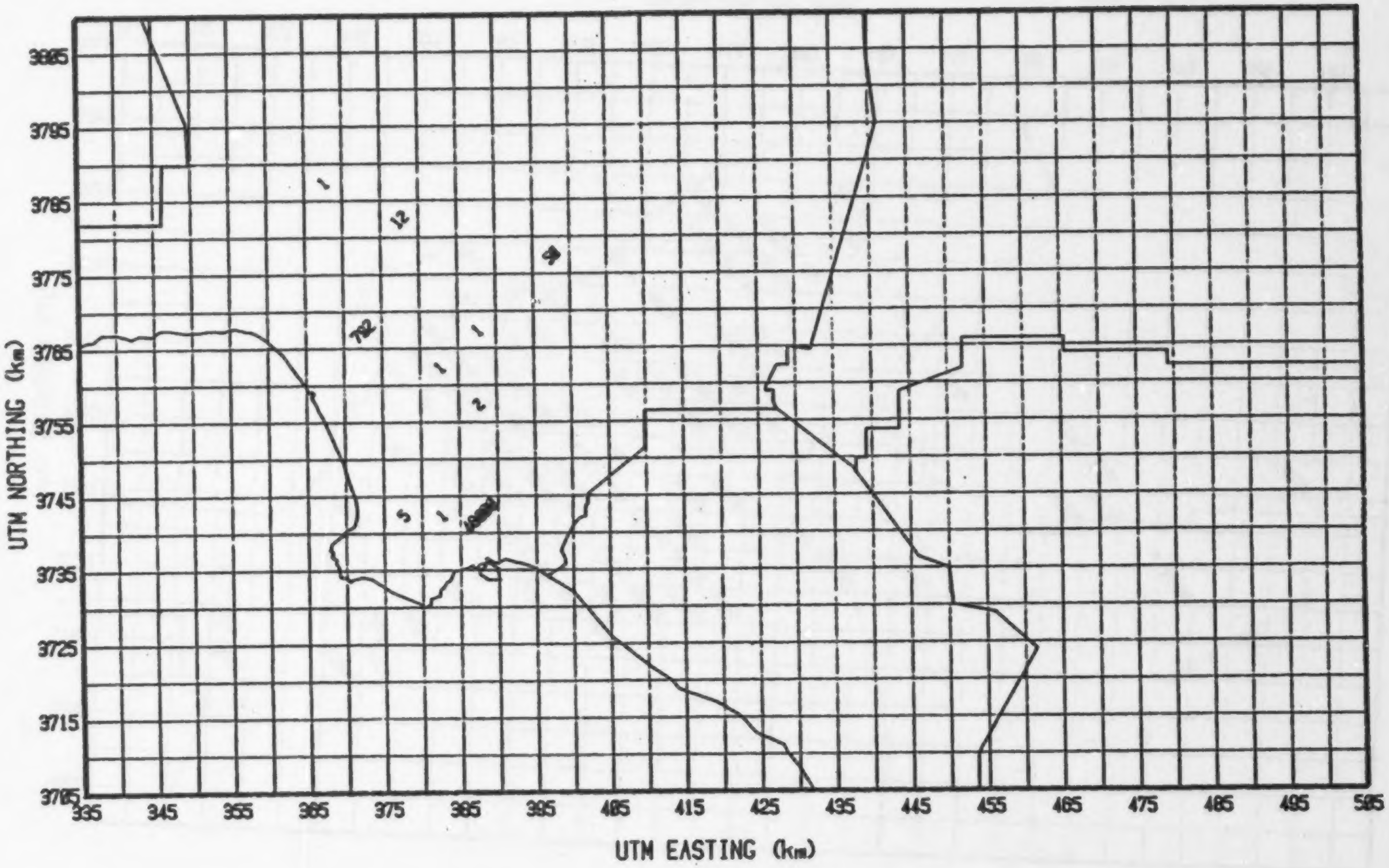
FIGURE A-10

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF MERCURY (lbs/yr)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365
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395
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415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)
1
12
782
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FIGURE A-11

DISTRIBUTION OF POINT SOURCE EMISSIONS OF METHYL BROMIDE (lbs/yr)

Reproduced from
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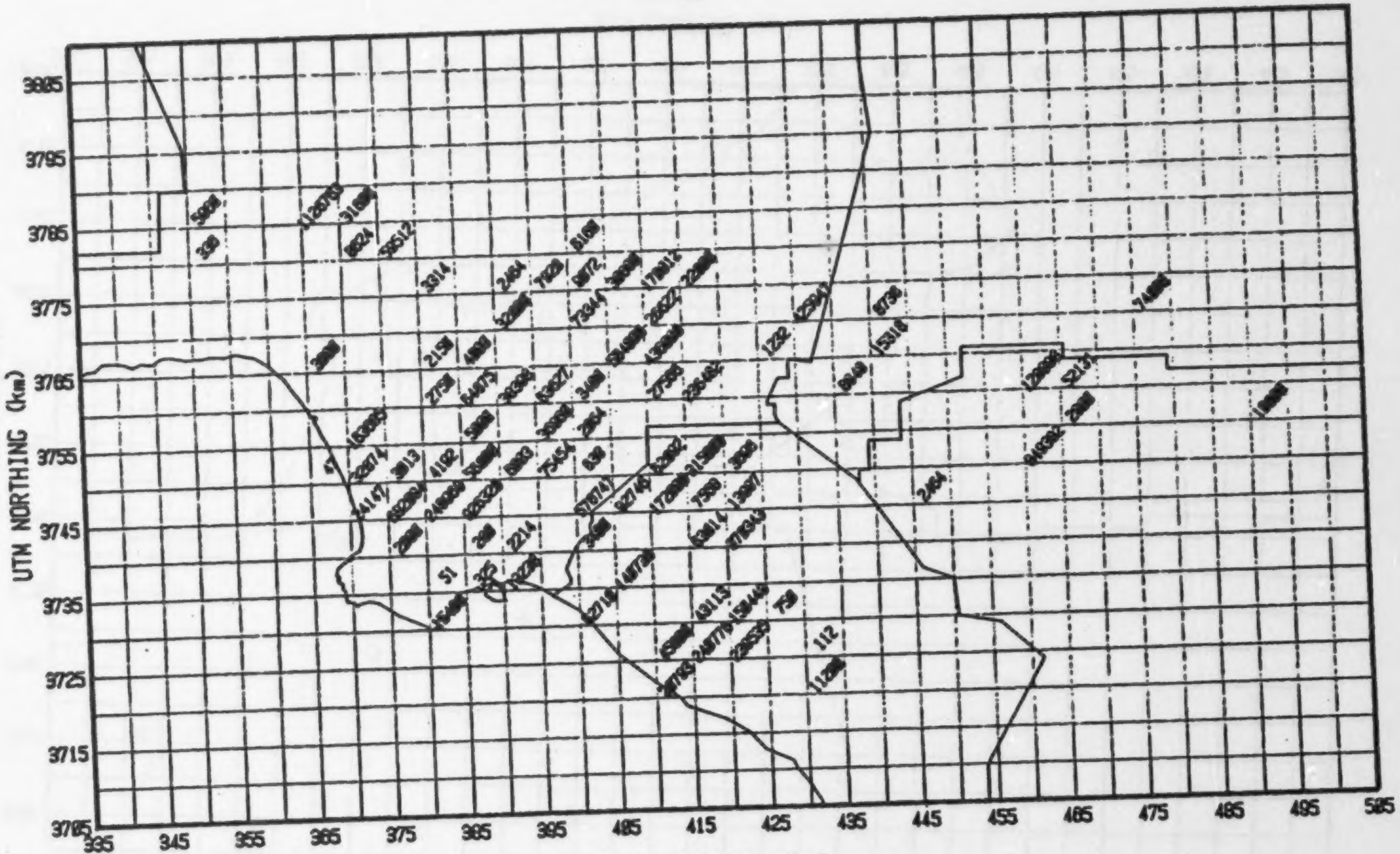
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UTM NORTHING (km)
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365
375
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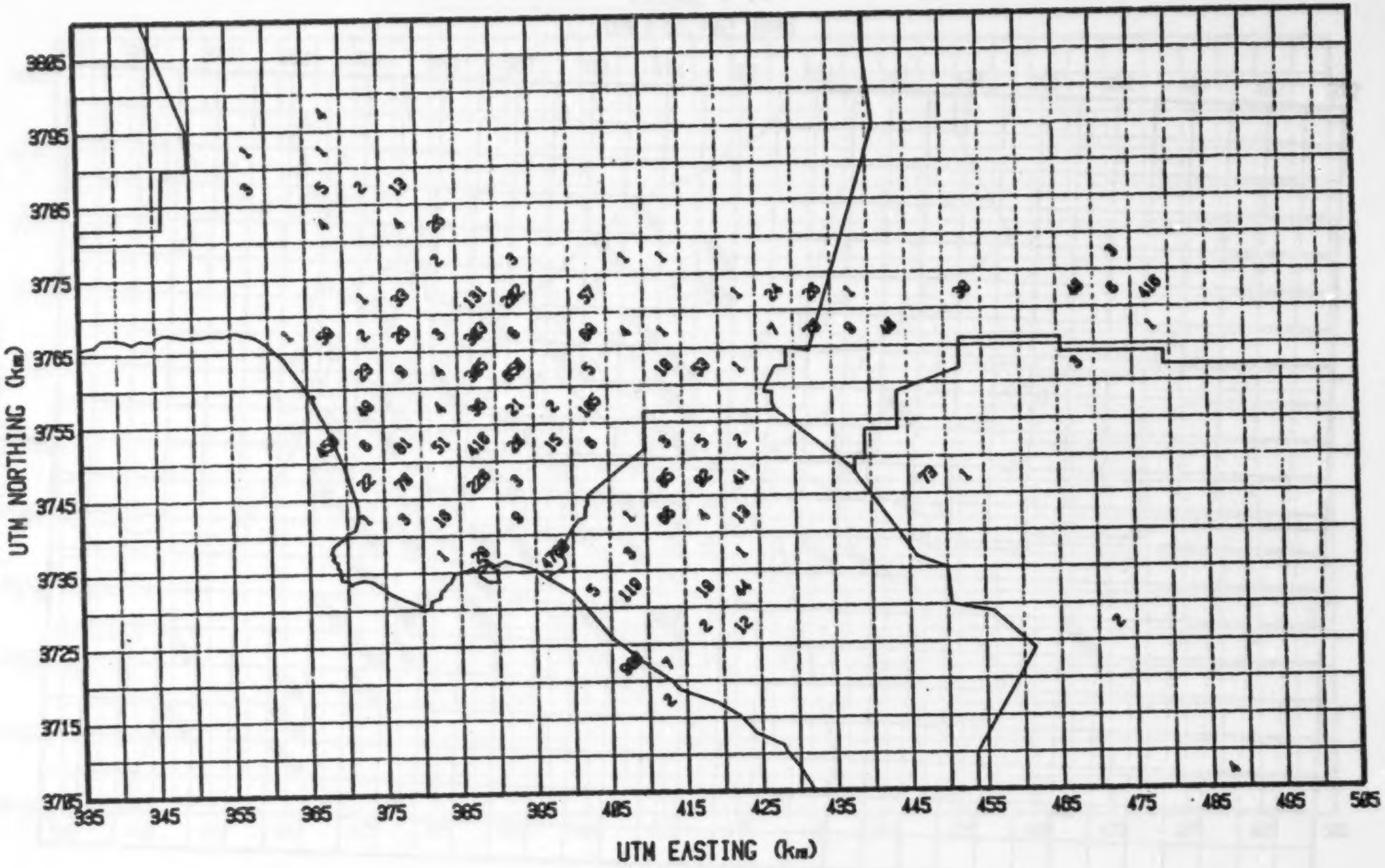
UTM EASTING (km)

FIGURE A-12

DISTRIBUTION OF POINT SOURCE EMISSIONS OF METHYLENE CHLORIDE (lbs/yr)

Reproduced from
best available copy.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UTM EASTING (km)
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345
355
365
375
385
395
405
415
425
435
445
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495
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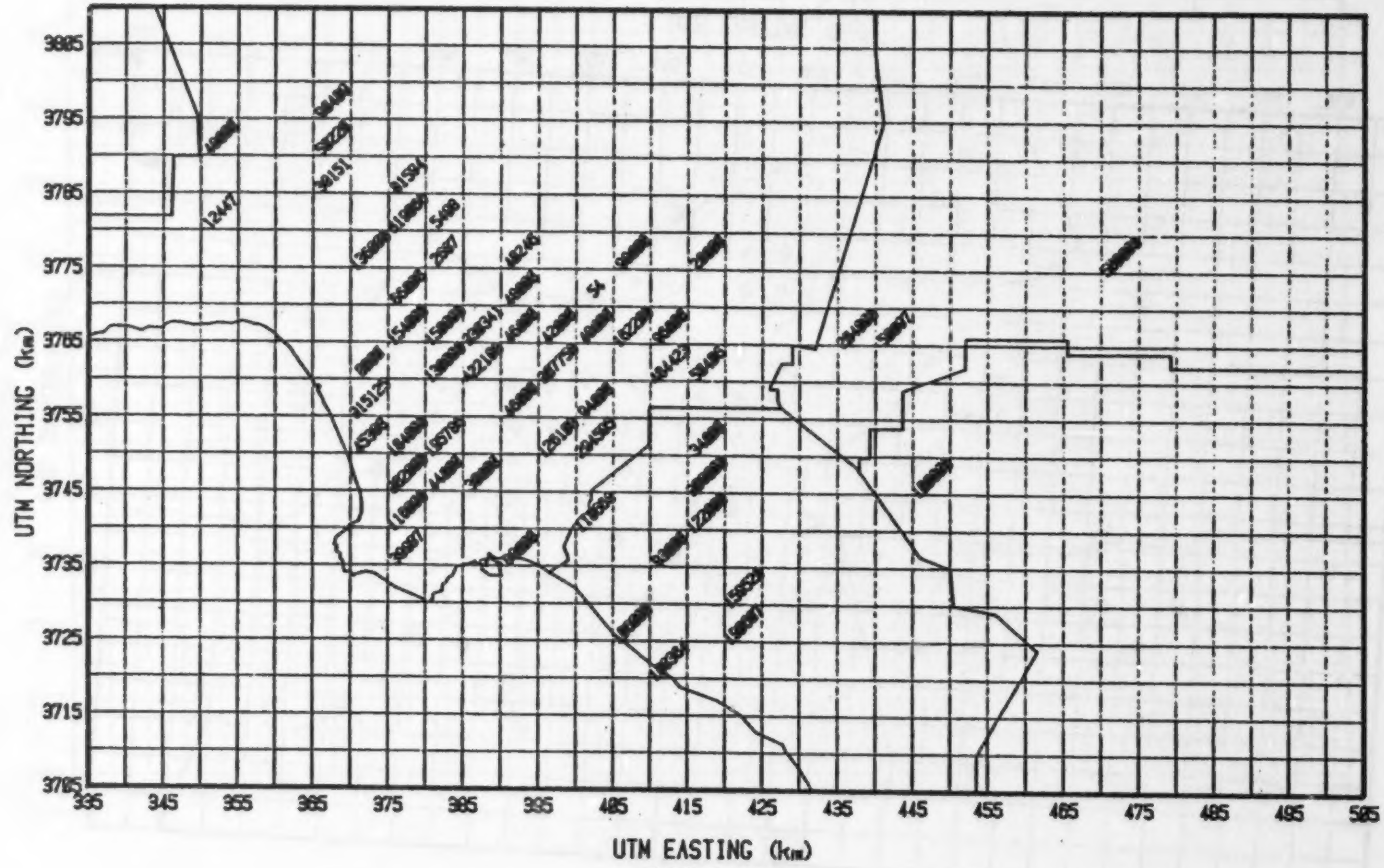
FIGURE A-13

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF NICKEL (lbs/yr)

Reproduced from
best available copy.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405
415
425
435
445
455
465
475
485
495
505
UTM NORTHING (km)
UTM EASTING (km)
12447
30151
81594
5498
2887
48245
54
315125

FIGURE A-14

DISTRIBUTION OF POINT SOURCE EMISSIONS OF PERCHLOROETHYLENE (lbs/yr)

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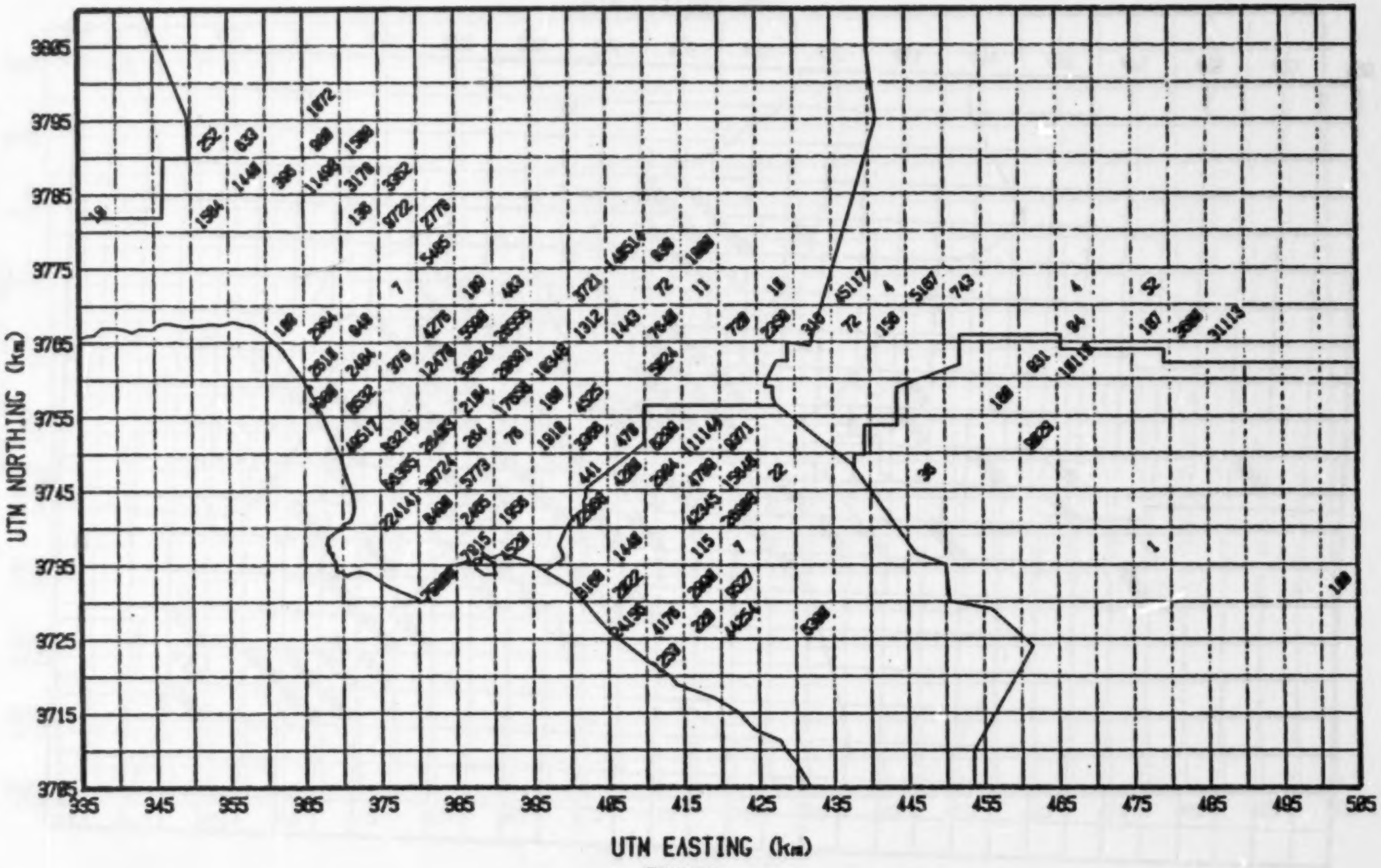
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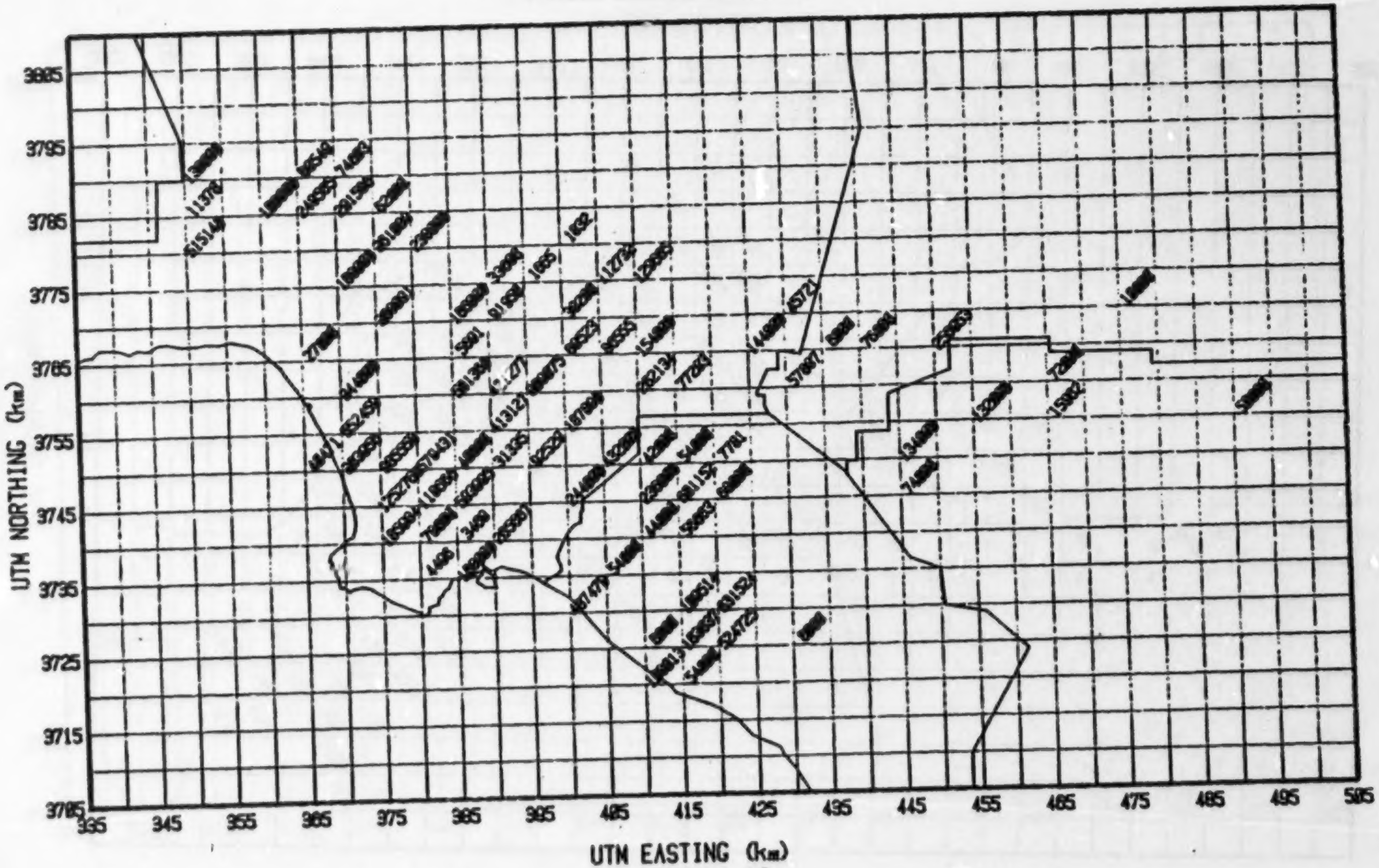
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE A-15

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF TOLUENE (lbs/yr)

Reproduced from
best available copy.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3775
3765
3755
3745
3735
3725
3715
3705
UTM NORTHING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE A-16

DISTRIBUTION OF POINT SOURCE EMISSIONS OF 1, 1, 1-TRICHLOROETHANE (lbs/yr)

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best available copy.

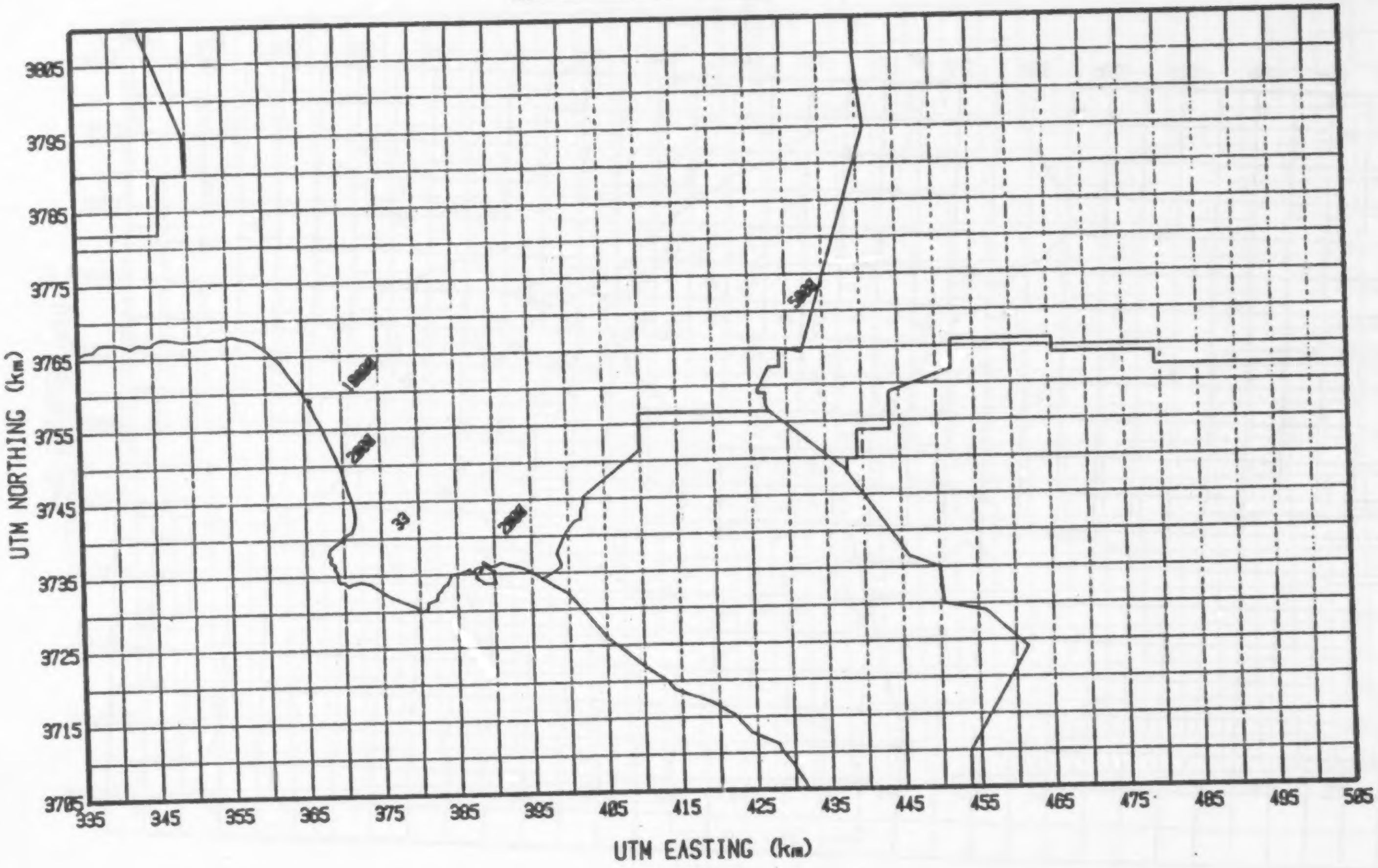
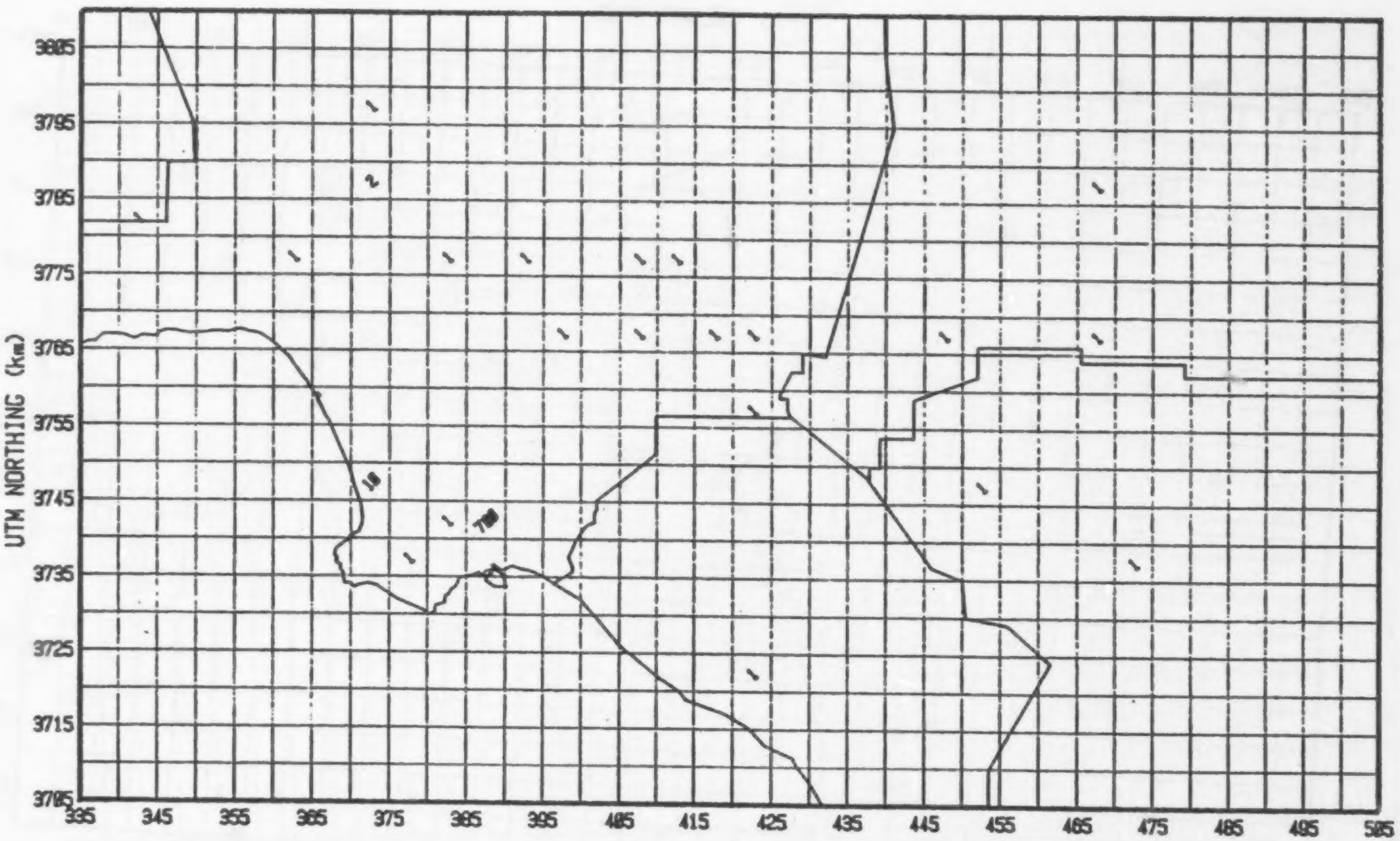

UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)
10000
2000
33
2000
5000

FIGURE A-17

DISTRIBUTION OF POINT SOURCE EMISSIONS OF TRICHLOROETHYLENE (lbs/yr)


UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
1
2
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

UTM EASTING (km)
FIGURE A-18

DISTRIBUTION OF POINT SOURCE EMISSIONS OF VINYL CHLORIDE (lbs/yr)

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Reproduced from
best available copy.

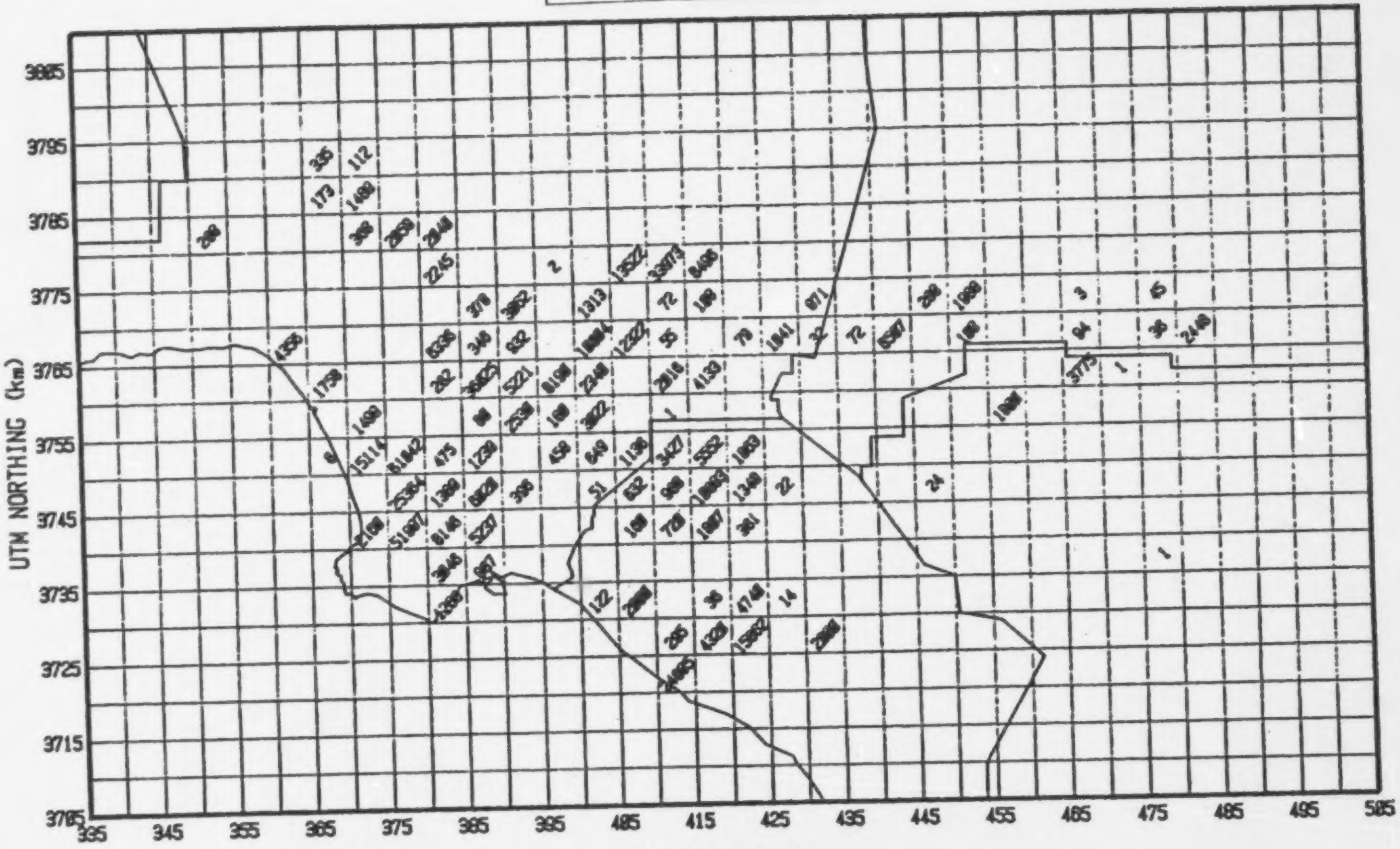

UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
335
112
173
1498
2245
2
1313
378
348
632
5221
282
1738
1498
15114
81842
475
1239
458
649
1136
25364
1388
306
51
632
51897
8146
3846
122
33973
8496
72
198
55
2316
4133
79
1041
971
32
72
5587
298
1988
188
3
65
94
38
2449
3775
1
1
3427
5552
1863
988
1349
22
189
728
1987
381
24
36
4748
14
285
4329
15862
1
UTM EASTING (km)

FIGURE A-19

SPATIAL DISTRIBUTION OF POINT SOURCE EMISSIONS OF XYLENES (lbs/yr)

APPENDIX B
SPATIAL DISTRIBUTION OF MODEL-PREDICTED AMBIENT CONCENTRATIONS

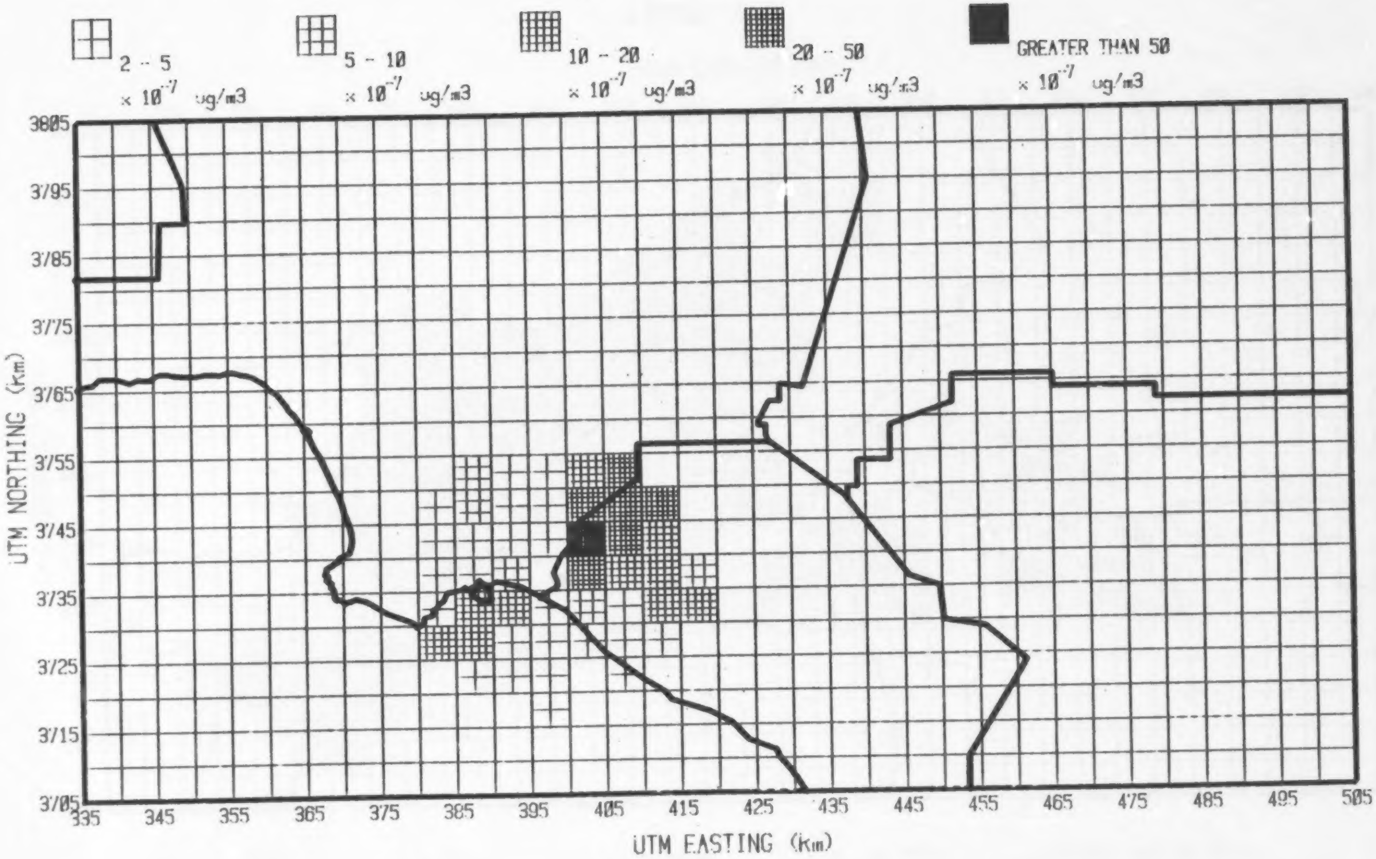

2 - 5 × 10^-7 ug/m3
5 - 10 × 10^-7 ug/m3
10 - 20 × 10^-7 ug/m3
20 - 50 × 10^-7 ug/m3
GREATER THAN 50 × 10^-7 ug/m3
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE B-1

MODEL PREDICTED ANNUAL AVERAGE ARSENIC CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

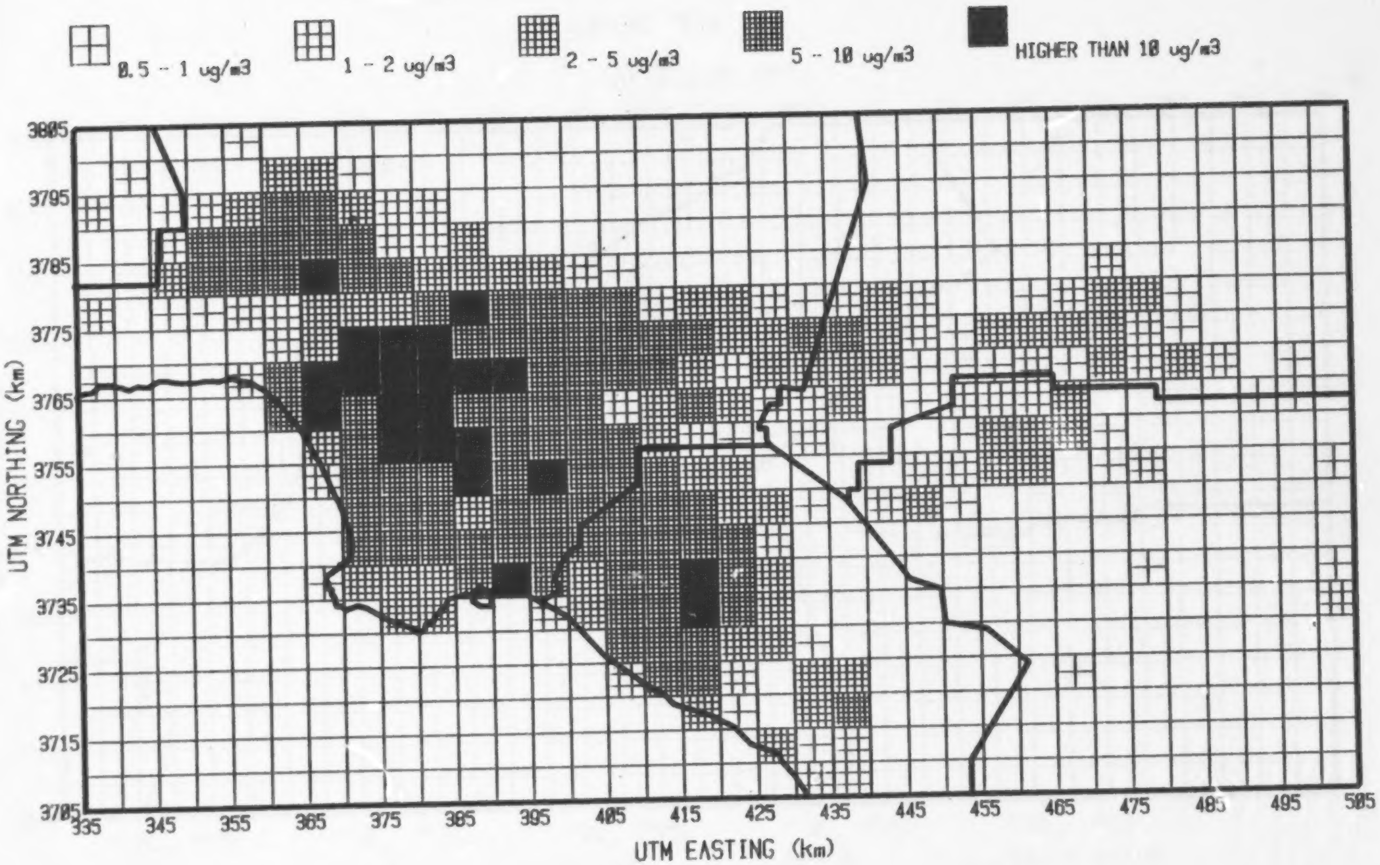

0.5 - 1 ug/m3
1 - 2 ug/m3
2 - 5 ug/m3
5 - 10 ug/m3
HIGHER THAN 10 ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE B-2

MODEL PREDICTED ANNUAL AVERAGE BENZENE CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

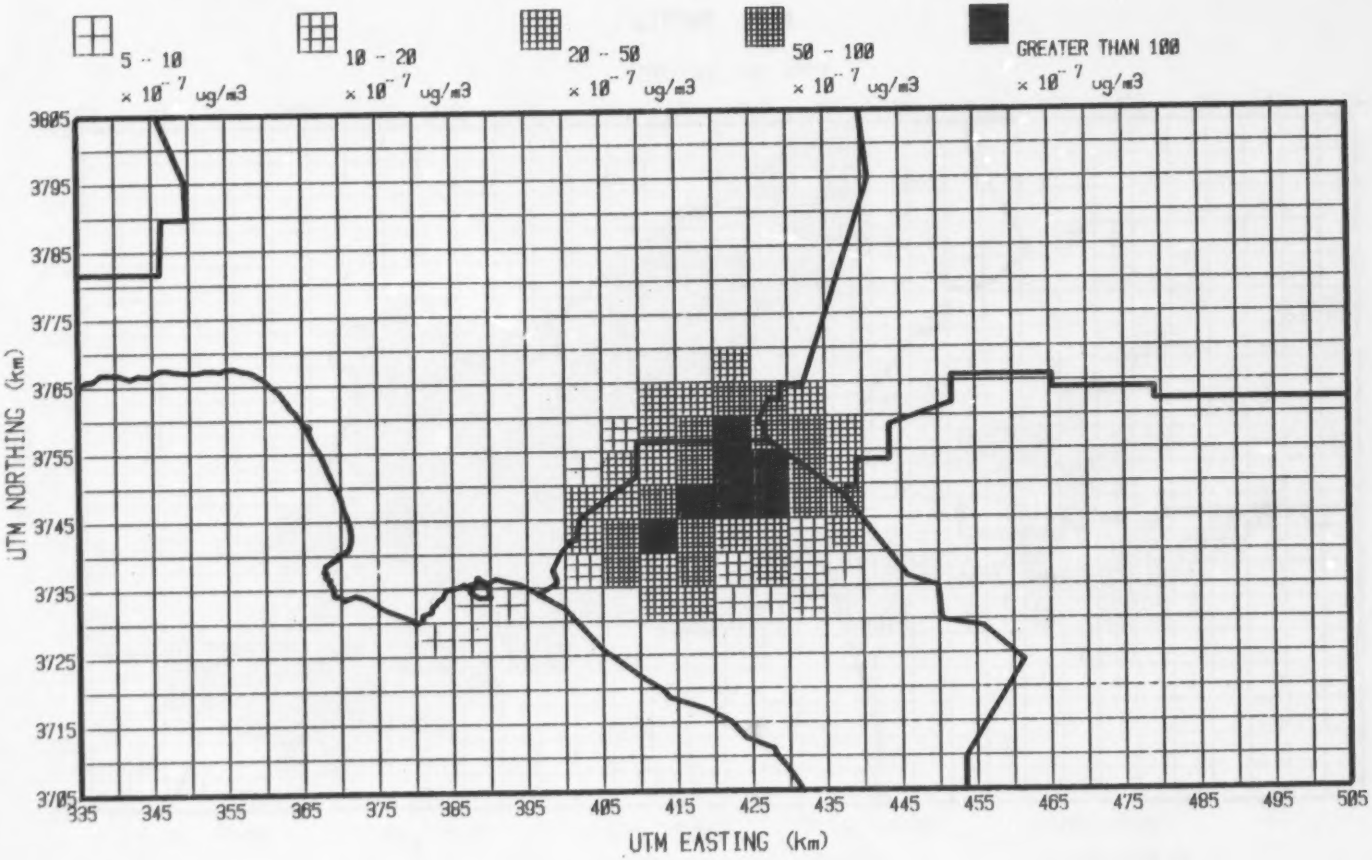

5 - 10 × 10⁻⁷ ug/m3
10 - 20 × 10⁻⁷ ug/m3
20 - 50 × 10⁻⁷ ug/m3
50 - 100 × 10⁻⁷ ug/m3
GREATER THAN 100 × 10⁻⁷ ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-3

MODEL PREDICTED ANNUAL AVERAGE BERYLLIUM CONCENTRATION IN THE SOUTH COAST AIR BASIN

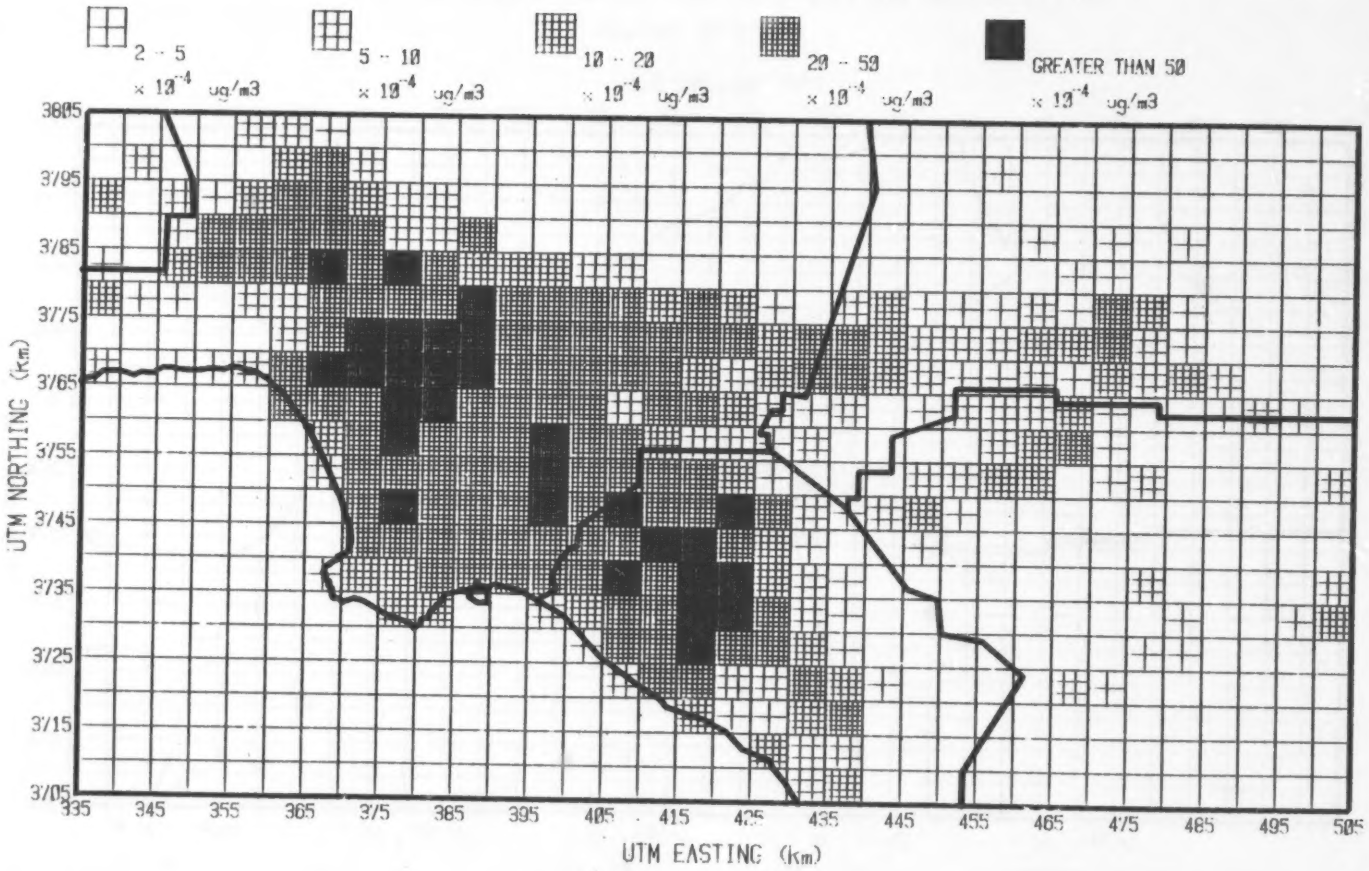

2 - 5 × 10^-4 ug/m3
5 - 10 × 10^-4 ug/m3
10 - 20 × 10^-4 ug/m3
20 - 50 × 10^-4 ug/m3
GREATER THAN 50 × 10^-4 ug/m3
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM NORTHING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-4

MODEL PREDICTED ANNUAL AVERAGE CADMIUM CONCENTRATIONS IN THE SOUTH COAST AIR BASIN

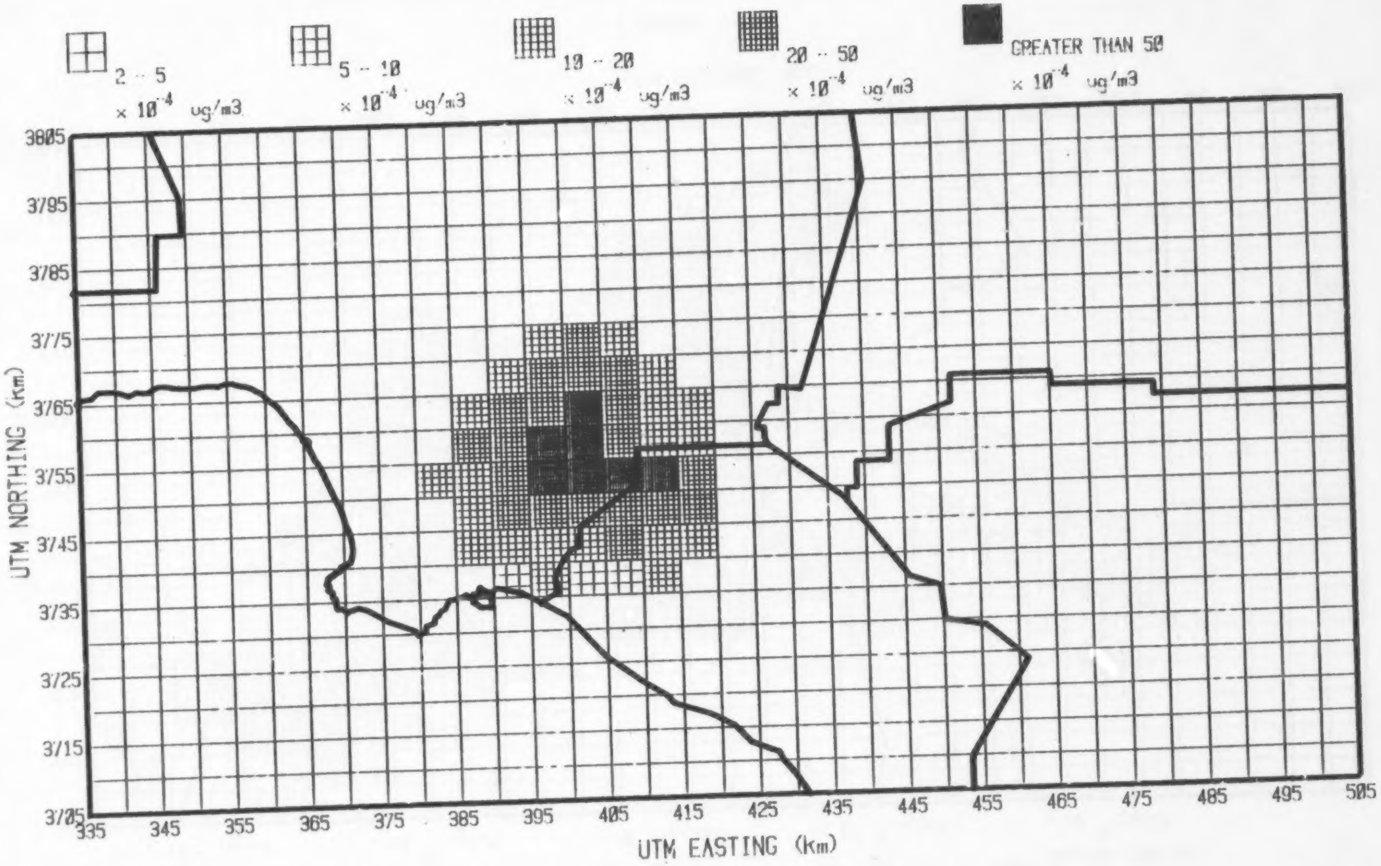

2 - 5 × 10⁻⁴ ug/m3
5 - 10 × 10⁻⁴ ug/m3
10 - 20 × 10⁻⁴ ug/m3
20 - 50 × 10⁻⁴ ug/m3
GREATER THAN 50 × 10⁻⁴ ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-5

MODEL PREDICTED ANNUAL AVERAGE CARBON TETRACHLORIDE CONCENTRATIONS IN THE SOUTH COAST AIR BASIN

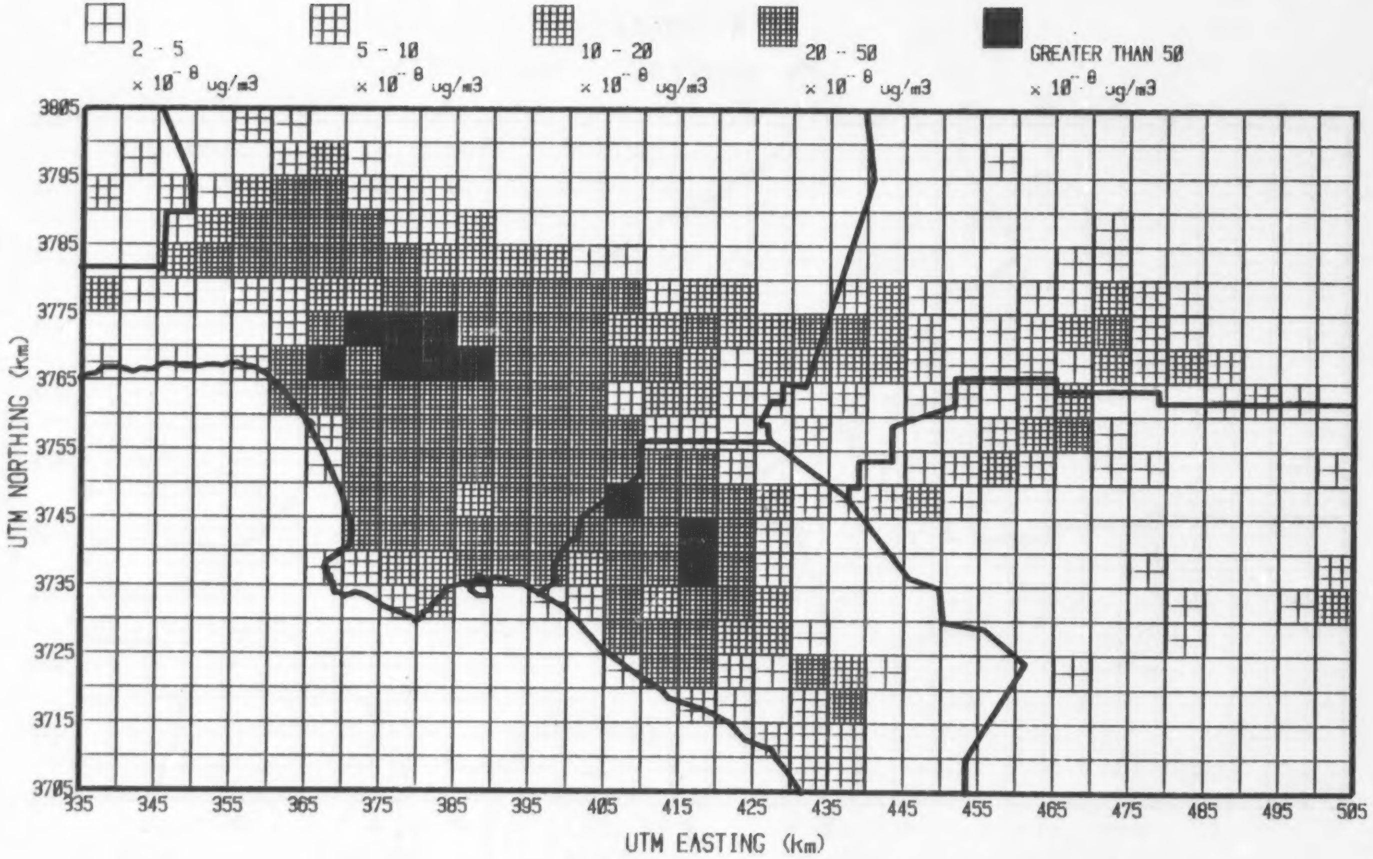

2 - 5 × 10⁻⁸ ug/m3
5 - 10 × 10⁻⁸ ug/m3
10 - 20 × 10⁻⁸ ug/m3
20 - 50 × 10⁻⁸ ug/m3
GREATER THAN 50 × 10⁻⁸ ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-6

MODEL PREDICTED ANNUAL AVERAGE CHLOROFORM CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

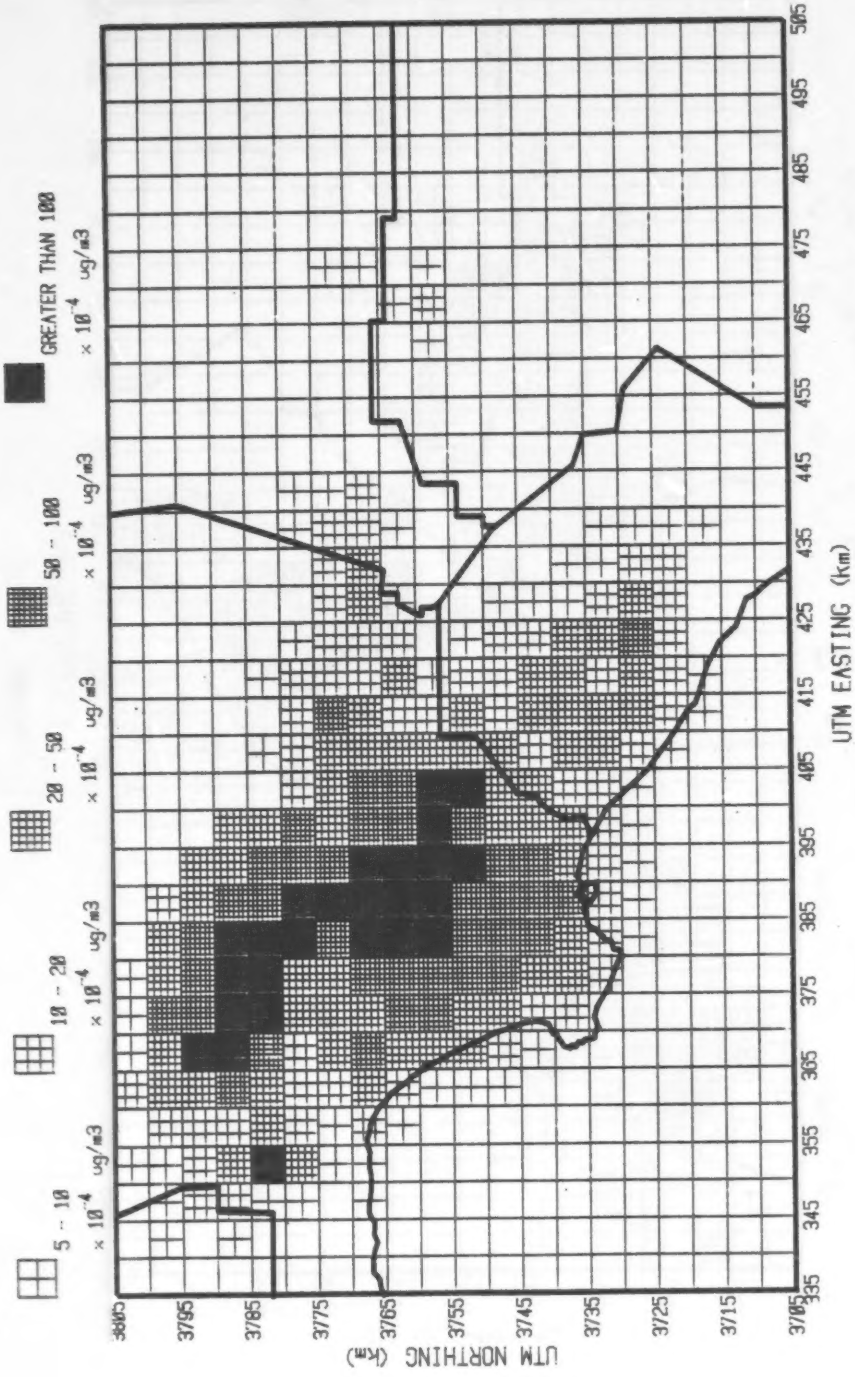
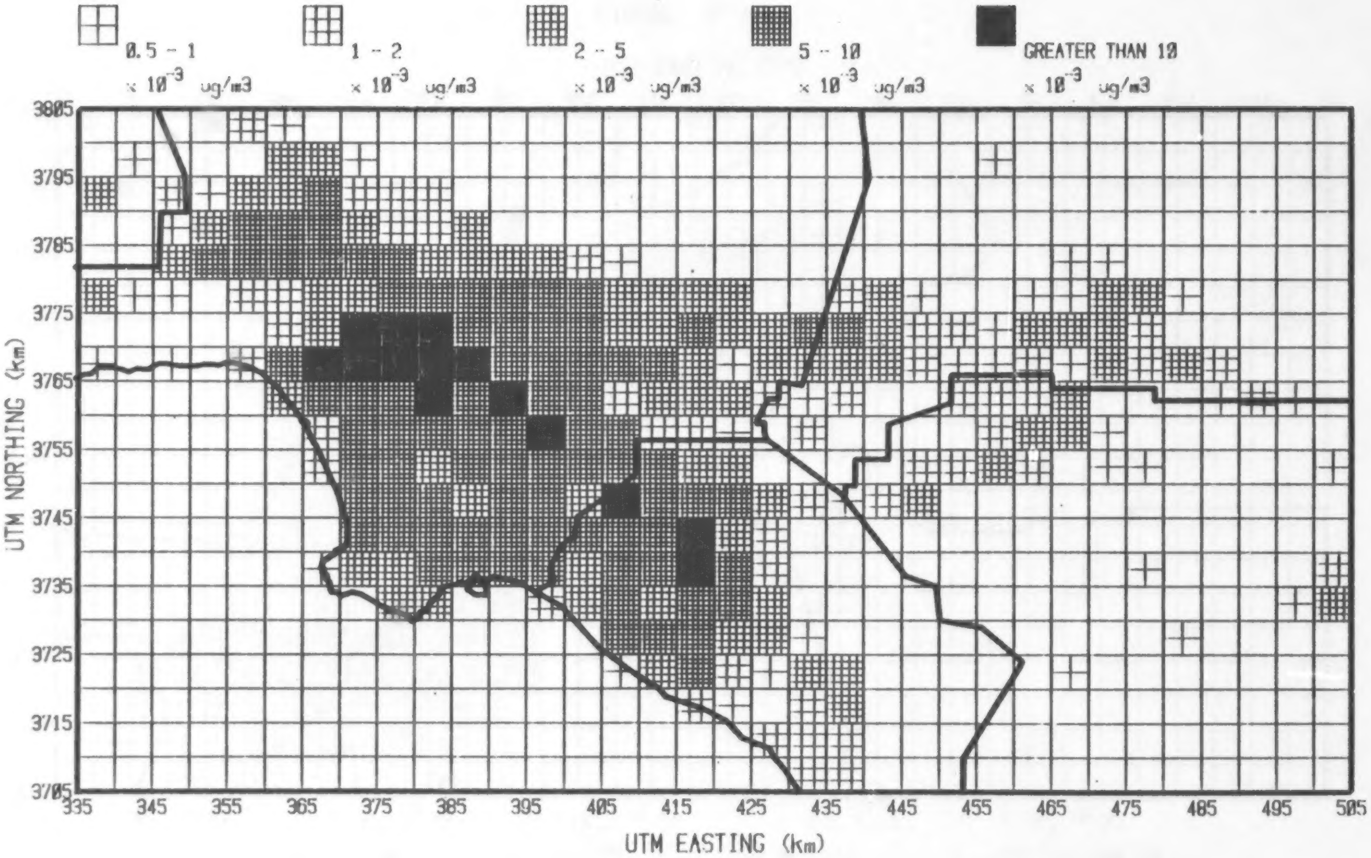

5 - 10 × 10^-4 ug/m3
10 - 20 × 10^-4 ug/m3
20 - 50 × 10^-4 ug/m3
50 - 100 × 10^-4 ug/m3
GREATER THAN 100 × 10^-4 ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE B-7

MODEL PREDICTED ANNUAL AVERAGE CHROMIUM (VI) CONCENTRATIONS IN THE SOUTH COAST AIR BASIN



0.5 - 1 × 10^-3 ug/m3
1 - 2 × 10^-3 ug/m3
2 - 5 × 10^-3 ug/m3
5 - 10 × 10^-3 ug/m3
GREATER THAN 10 × 10^-3 ug/m3
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM NORTHING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-8

MODEL PREDICTED ANNUAL AVERAGE ETHYLENE DIBROMIDE CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

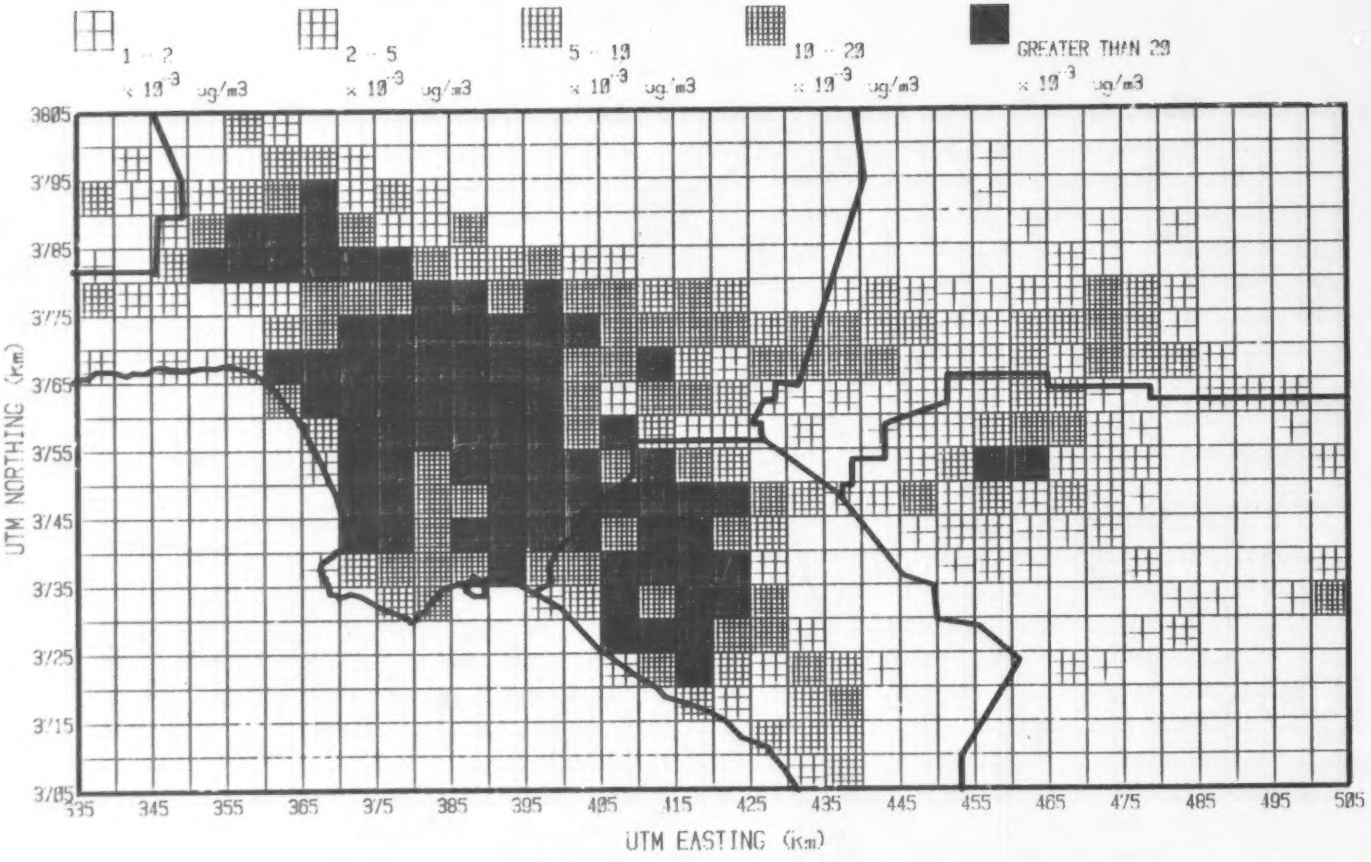

1 - 2 x 10^-3 ug/m3
2 - 5 x 10^-3 ug/m3
5 - 10 x 10^-3 ug/m3
10 - 20 x 10^-3 ug/m3
GREATER THAN 20 x 10^-3 ug/m3
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (Km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE B-9
MODEL PREDICTED ANNUAL AVERAGE ETHYLENE DICHLORIDE CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

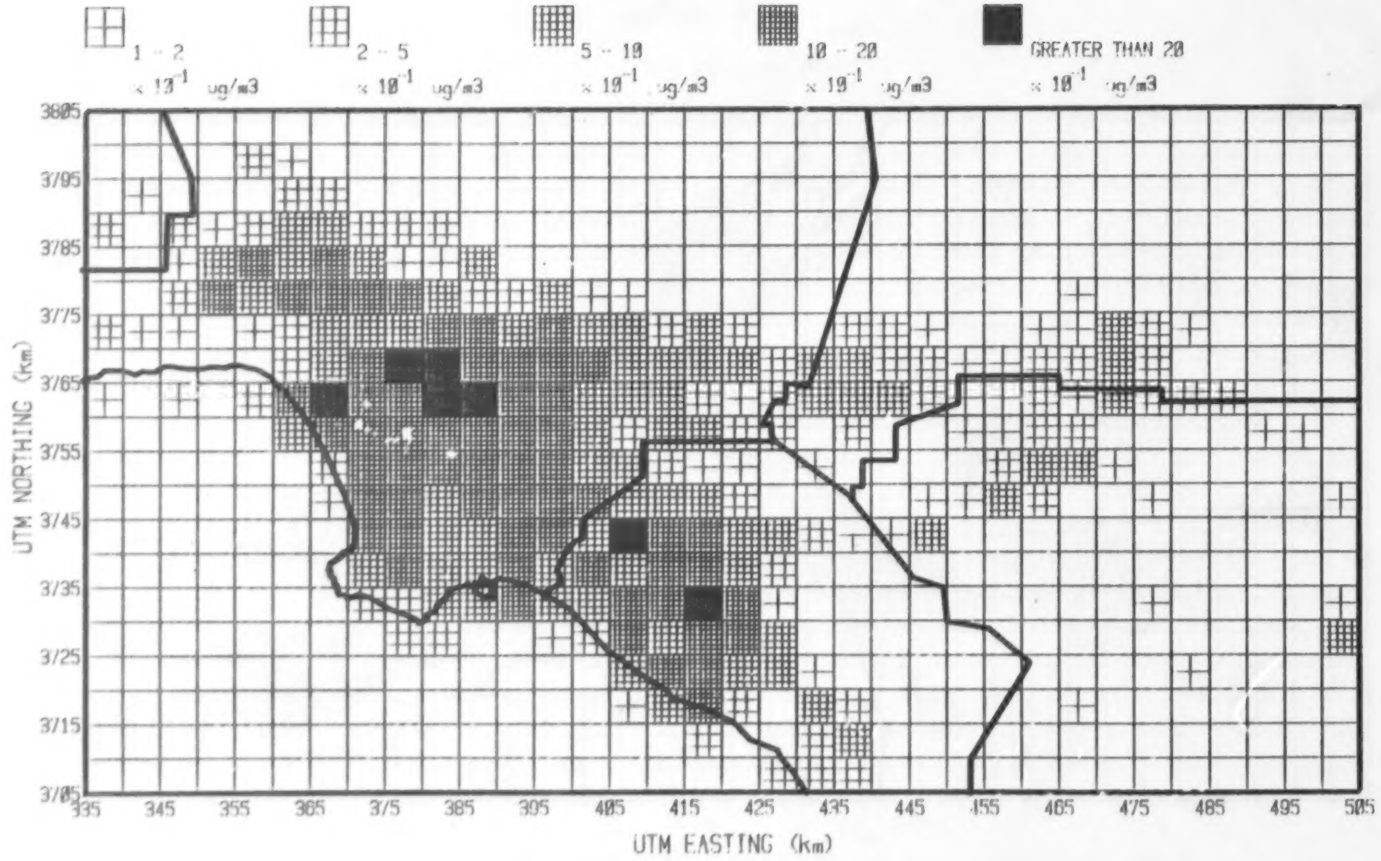

1 - 2 × 10⁻¹ ug/m3
2 - 5 × 10⁻¹ ug/m3
5 - 10 × 10⁻¹ ug/m3
10 - 20 × 10⁻¹ ug/m3
GREATER THAN 20 × 10⁻¹ ug/m3
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM NORTHING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-10
MODEL PREDICTED ANNUAL AVERAGE LEAD CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

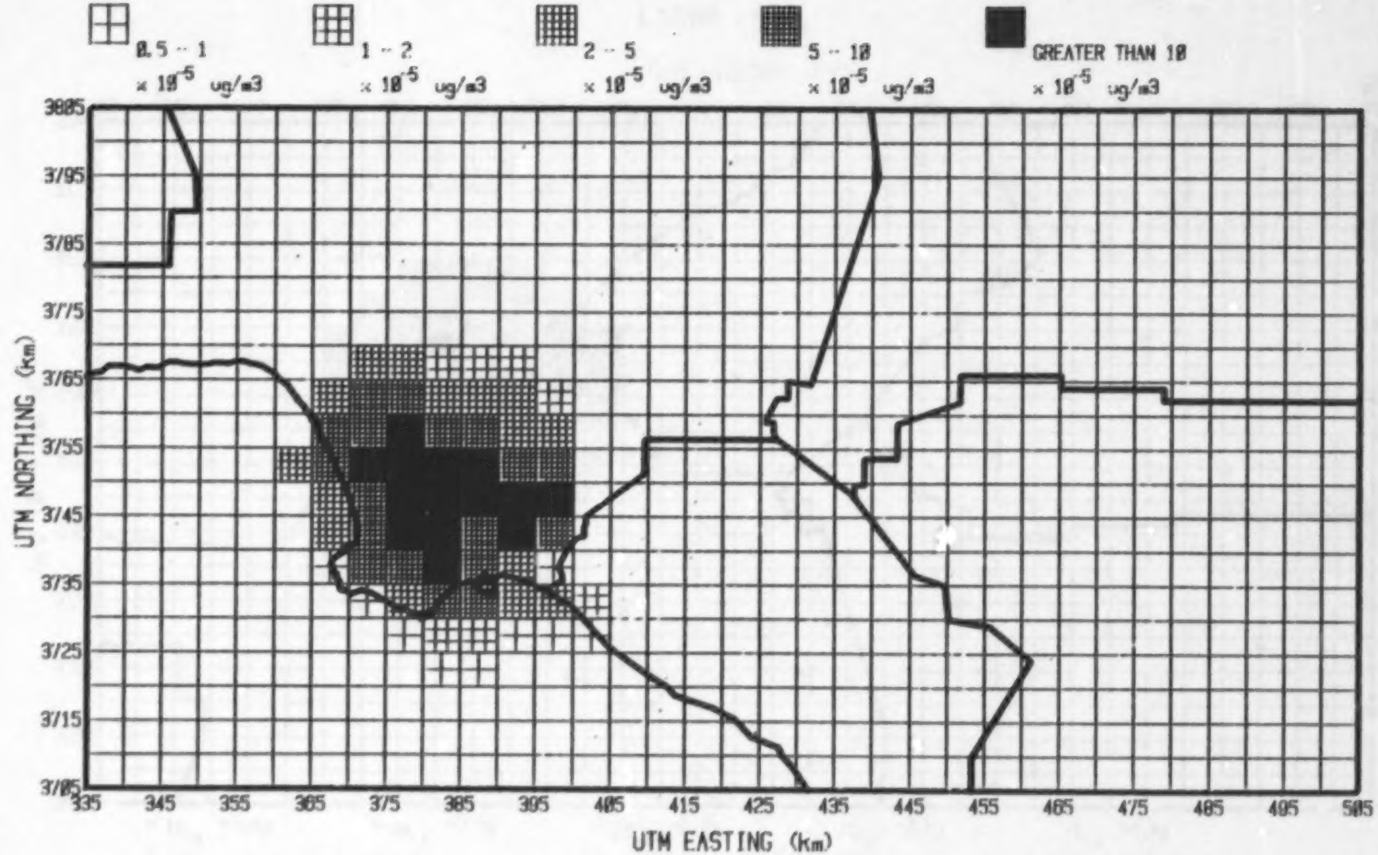

0.5 – 1 × 10^-5 ug/m3
1 – 2 × 10^-5 ug/m3
2 – 5 × 10^-5 ug/m3
5 – 10 × 10^-5 ug/m3
GREATER THAN 10 × 10^-5 ug/m3
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE B-11

MODEL PREDICTED ANNUAL AVERAGE MERCURY CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

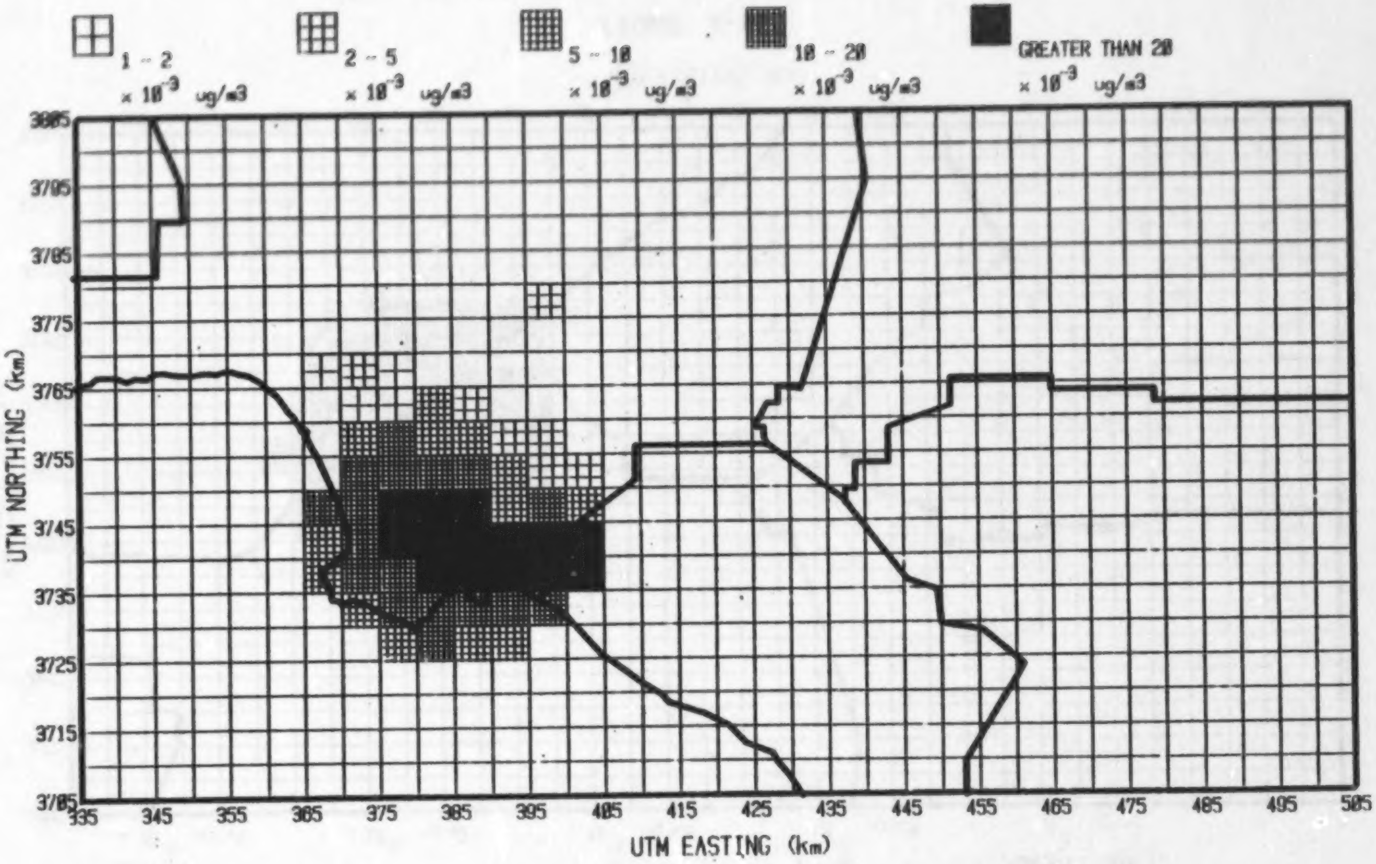

1 - 2 × 10⁻³ ug/m3
2 - 5 × 10⁻³ ug/m3
5 - 10 × 10⁻³ ug/m3
10 - 20 × 10⁻³ ug/m3
GREATER THAN 20 × 10⁻³ ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-12

MODEL PREDICTED ANNUAL AVERAGE METHYL BROMIDE CONCENTRATIONS IN THE SOUTH COAST AIR BASIN

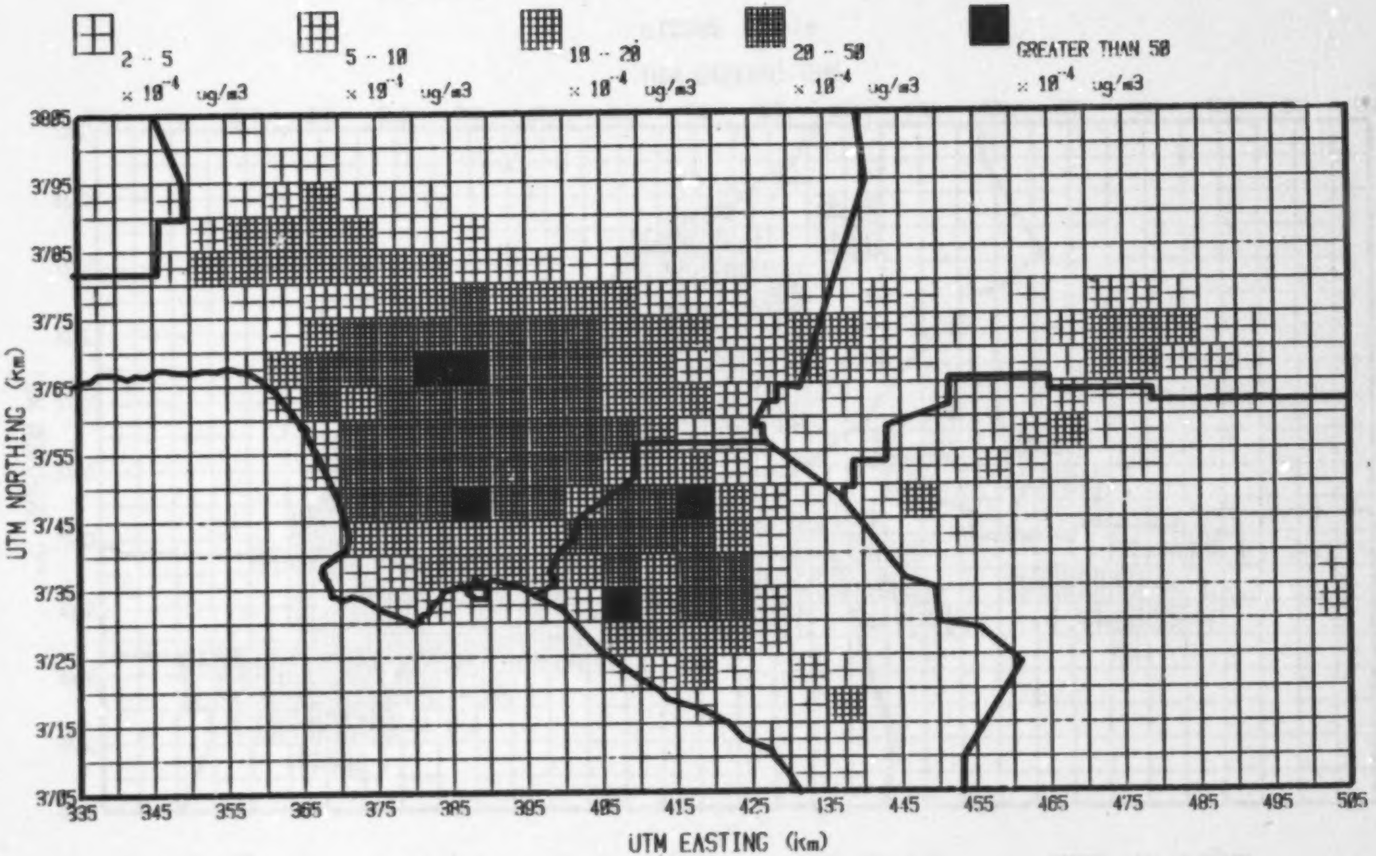
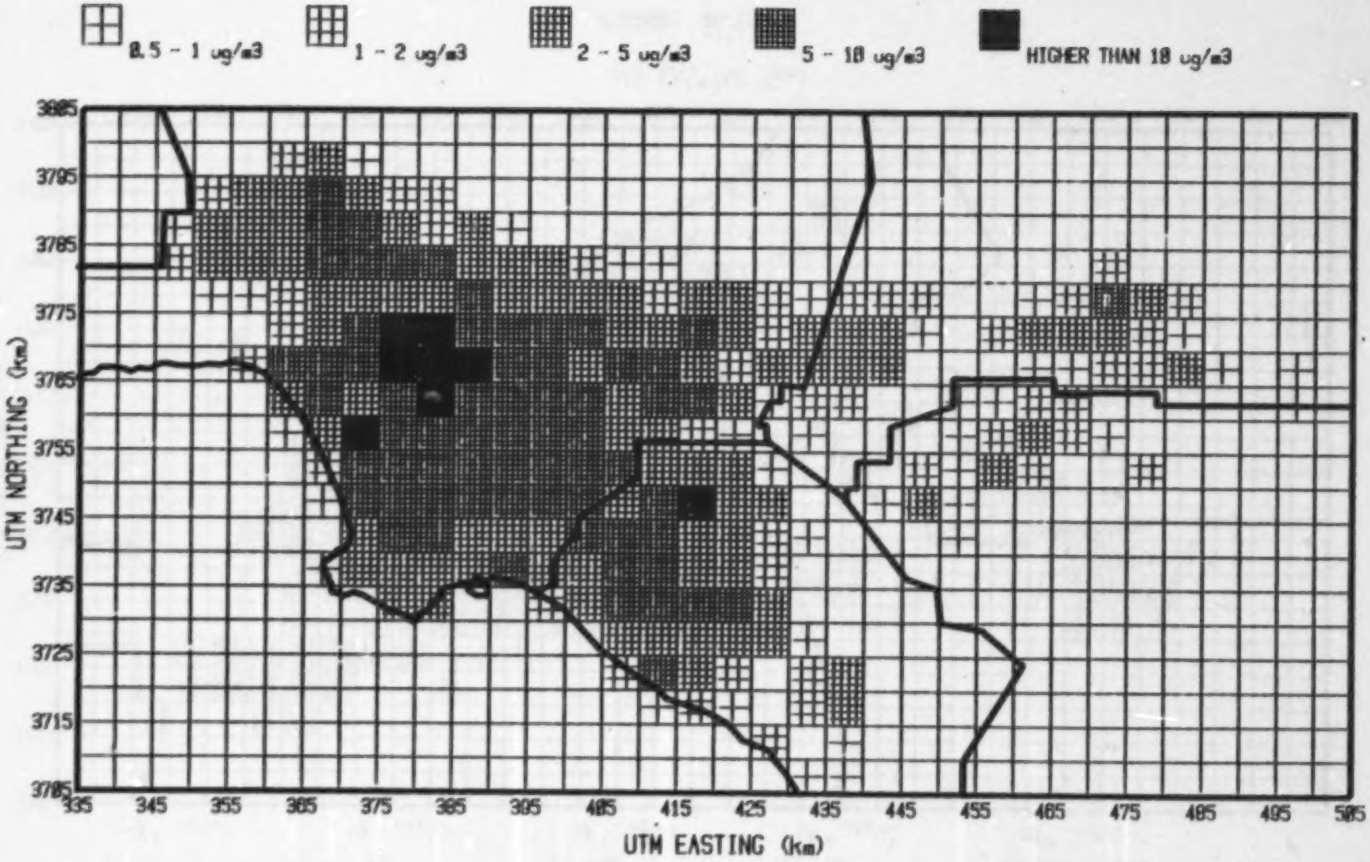

2 - 5 × 10^{-4} ug/m3
5 - 10 × 10^{-4} ug/m3
10 - 20 × 10^{-4} ug/m3
20 - 50 × 10^{-4} ug/m3
GREATER THAN 50 × 10^{-4} ug/m3
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

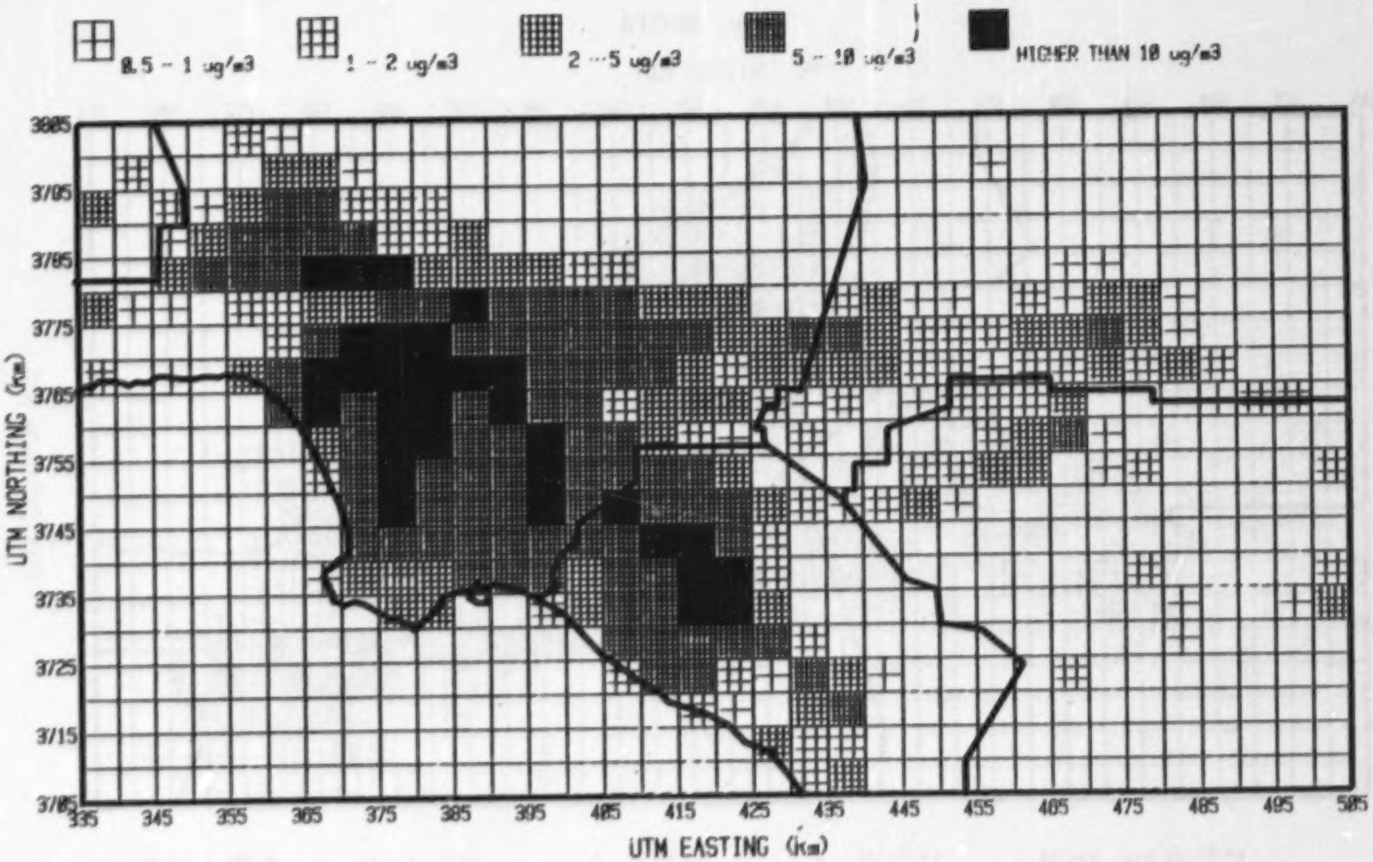
FIGURE B-13
MODEL PREDICTED ANNUAL AVERAGE NICKEL CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN



0.5 - 1 ug/m3
1 - 2 ug/m3
2 - 5 ug/m3
5 - 10 ug/m3
HIGHER THAN 10 ug/m3
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE B-14

MODEL PREDICTED ANNUAL AVERAGE PERCHLOROETHYLENE CONCENTRATIONS IN THE SOUTH COAST AIR BASIN



0.5 - 1 ug/m3
1 - 2 ug/m3
2 - 5 ug/m3
5 - 10 ug/m3
HIGHER THAN 10 ug/m3
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM NORTHING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-15

MODEL PREDICTED ANNUAL AVERAGE TOLUENE CONCENTRATIONS IN THE SOUTH COAST AIR BASIN

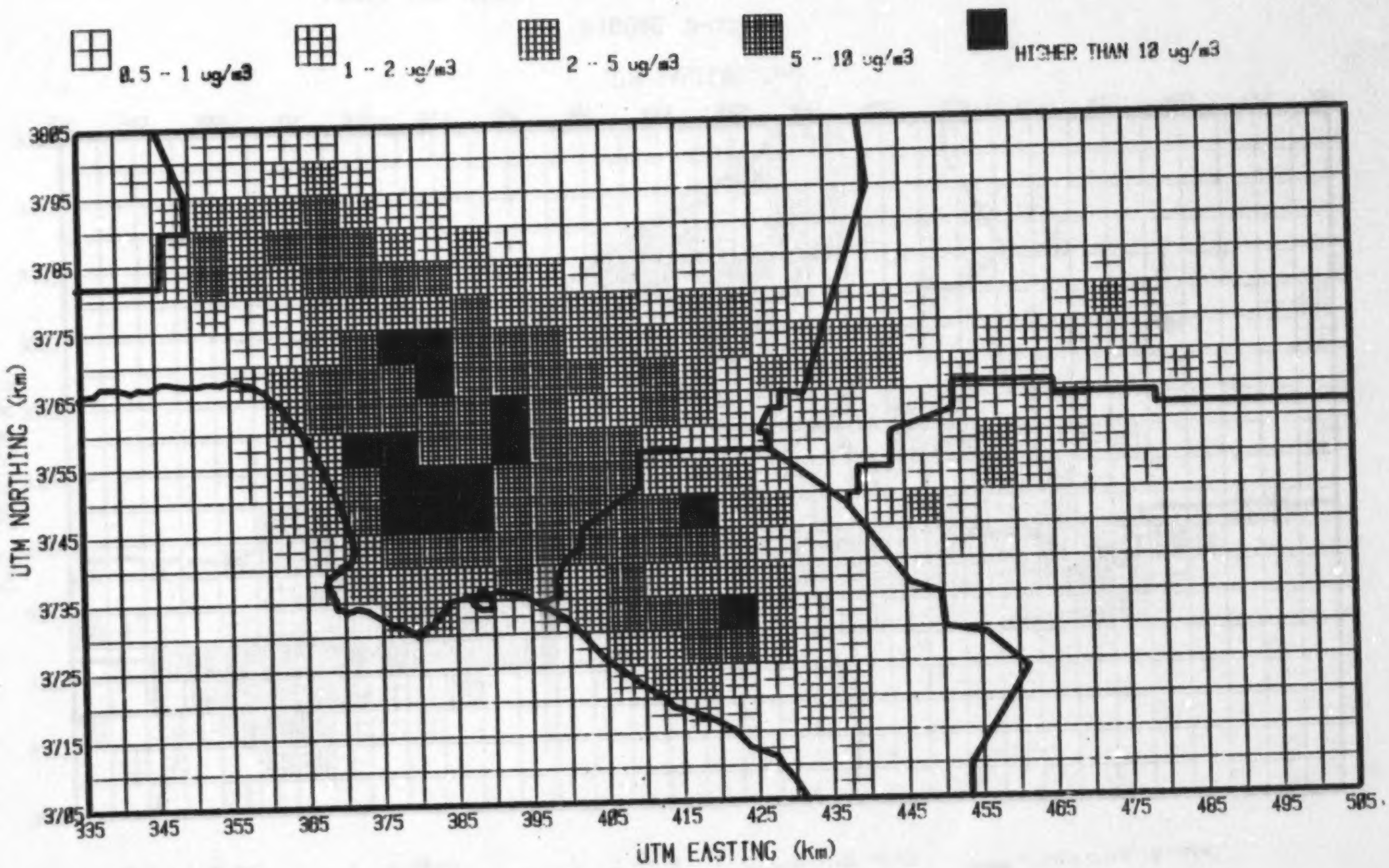

0.5 - 1 ug/m3
1 - 2 ug/m3
2 - 5 ug/m3
5 - 10 ug/m3
HIGHER THAN 10 ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE B-16

MODEL PREDICTED ANNUAL AVERAGE 1,1,1-TRICHLOROETHANE CONCENTRATIONS IN THE SOUTH COAST AIR BASIN

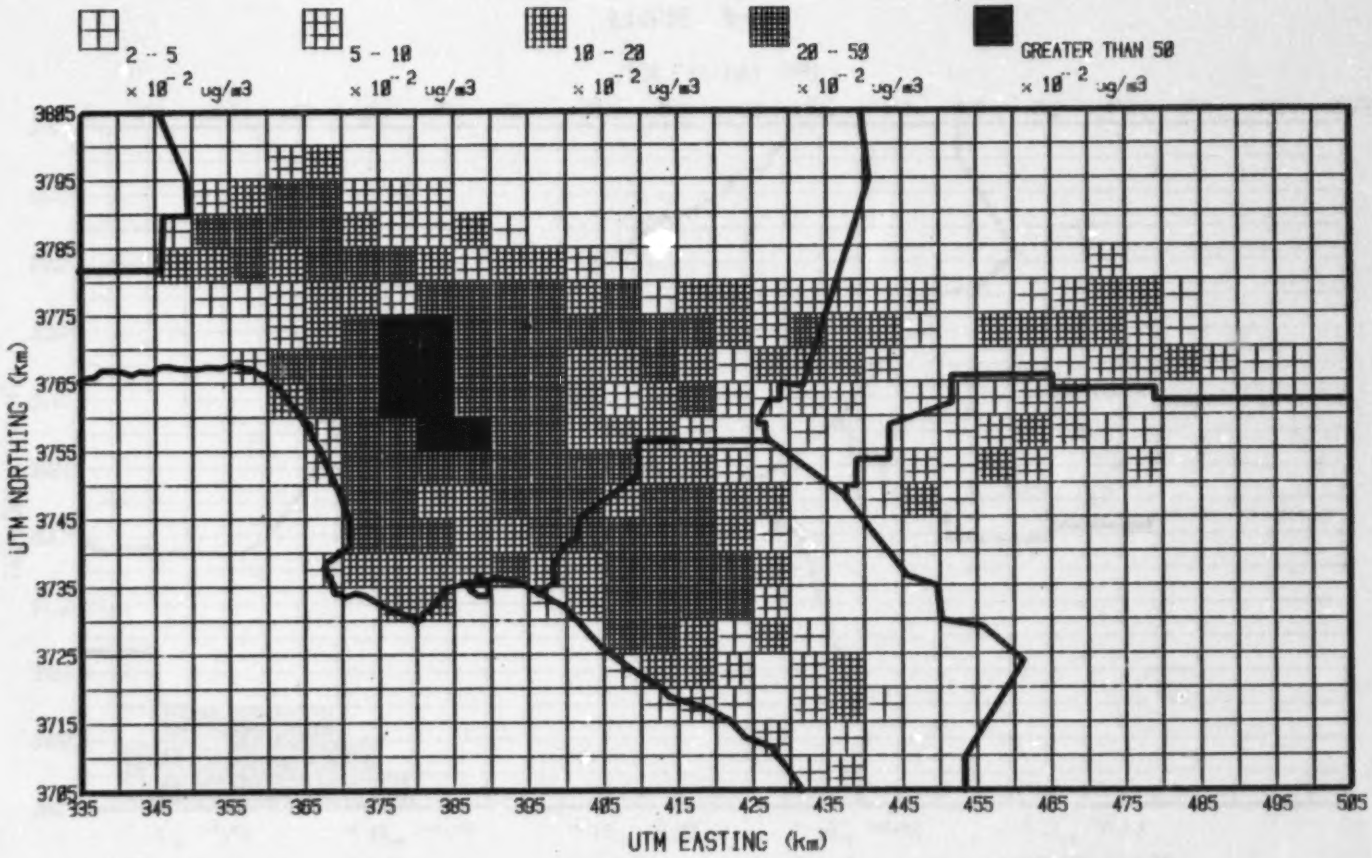
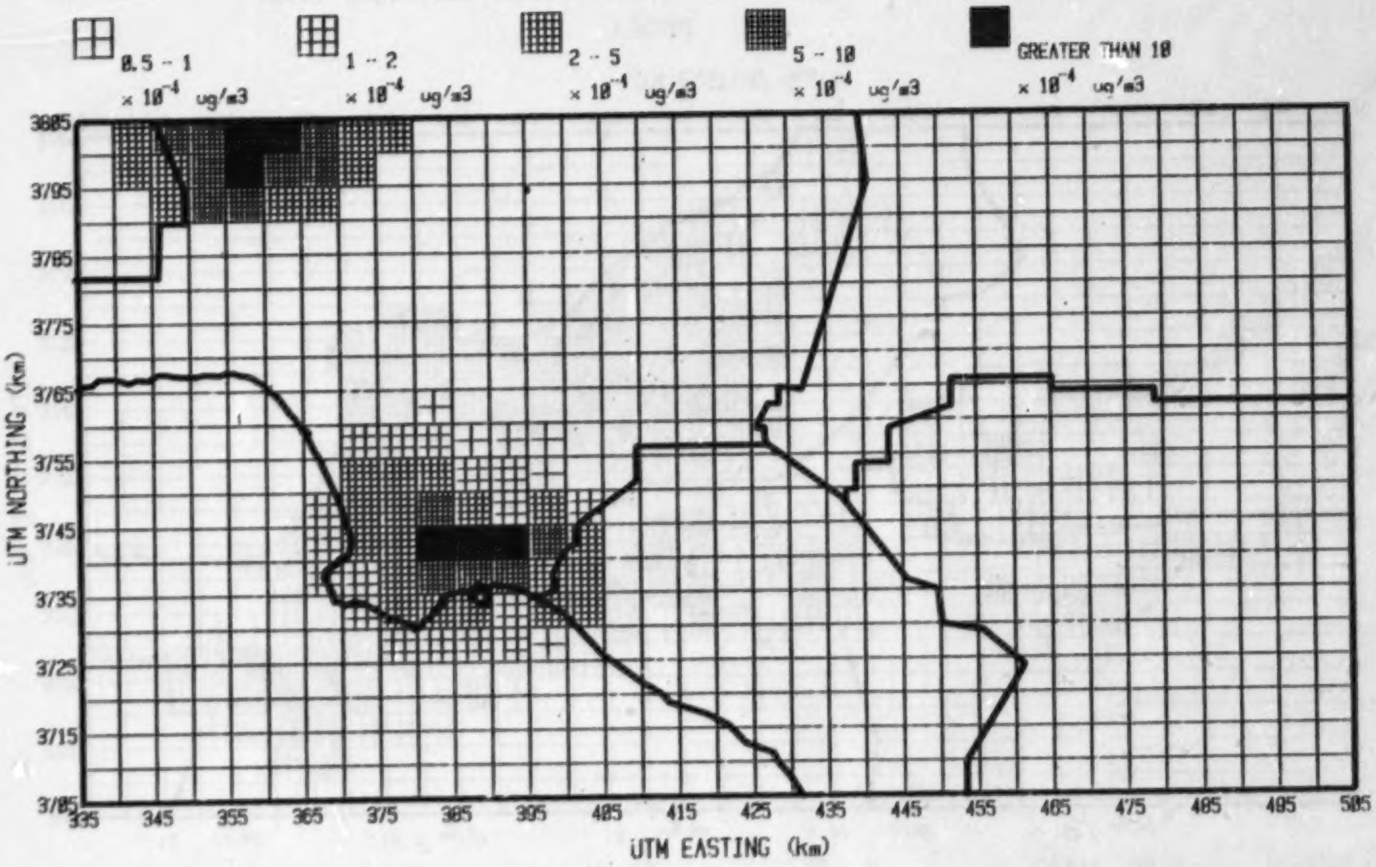

2 - 5 × 10⁻² ug/m3
5 - 10 × 10⁻² ug/m3
10 - 20 × 10⁻² ug/m3
20 - 50 × 10⁻² ug/m3
GREATER THAN 50 × 10⁻² ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-17

MODEL PREDICTED ANNUAL AVERAGE TRICHLOROETHYLENE CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN



0.5 - 1 × 10⁻⁴ ug/m3
1 - 2 × 10⁻⁴ ug/m3
2 - 5 × 10⁻⁴ ug/m3
5 - 10 × 10⁻⁴ ug/m3
GREATER THAN 10 × 10⁻⁴ ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE B-18

MODEL PREDICTED ANNUAL AVERAGE VINYL CHLORIDE CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

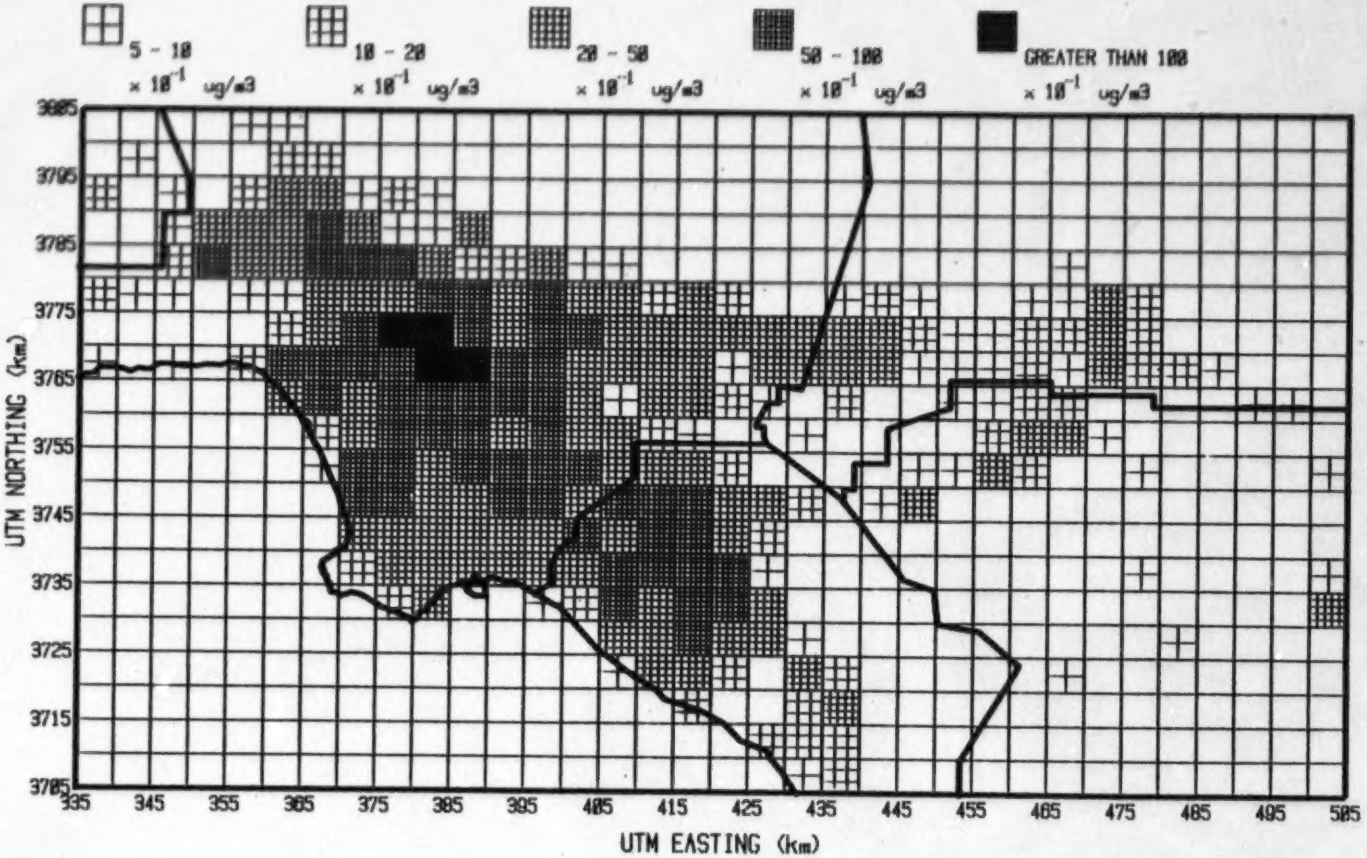

5 - 10 × 10^-1 ug/m3
10 - 20 × 10^-1 ug/m3
20 - 50 × 10^-1 ug/m3
50 - 100 × 10^-1 ug/m3
GREATER THAN 100 × 10^-1 ug/m3
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE B-19
MODEL PREDICTED ANNUAL AVERAGE XYLENES CONCENTRATIONS
IN THE SOUTH COAST AIR BASIN

APPENDIX C
SPATIAL DISTRIBUTION OF INDIVIDUAL CANCER RISKS AND NUMBER OF EXCESS CANCER IN THE SOUTH COAST AIR BASIN

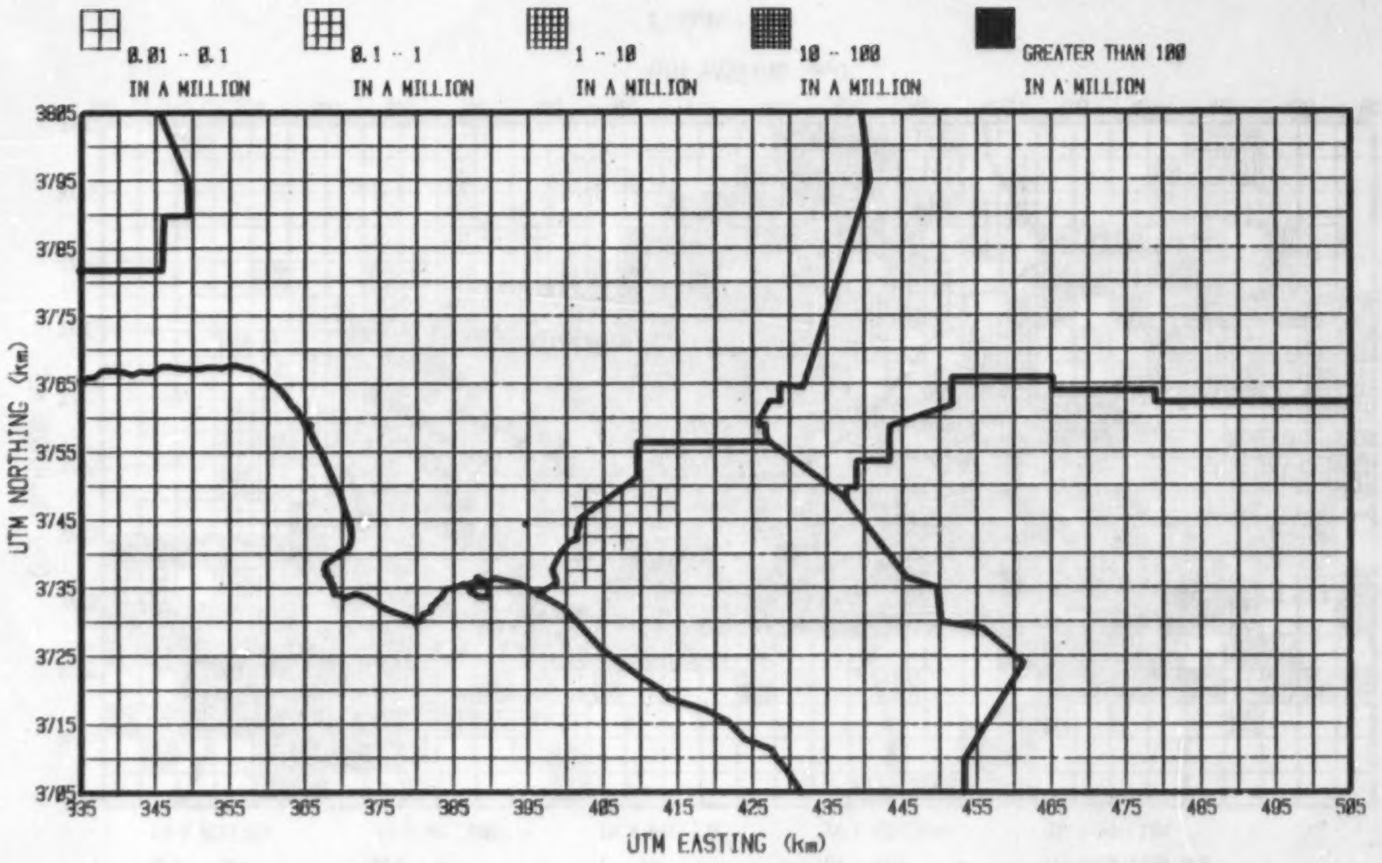

0.01 – 0.1 IN A MILLION
0.1 – 1 IN A MILLION
1 – 10 IN A MILLION
10 – 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-1

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT ARSENIC IN THE SOUTH COAST AIR BASIN

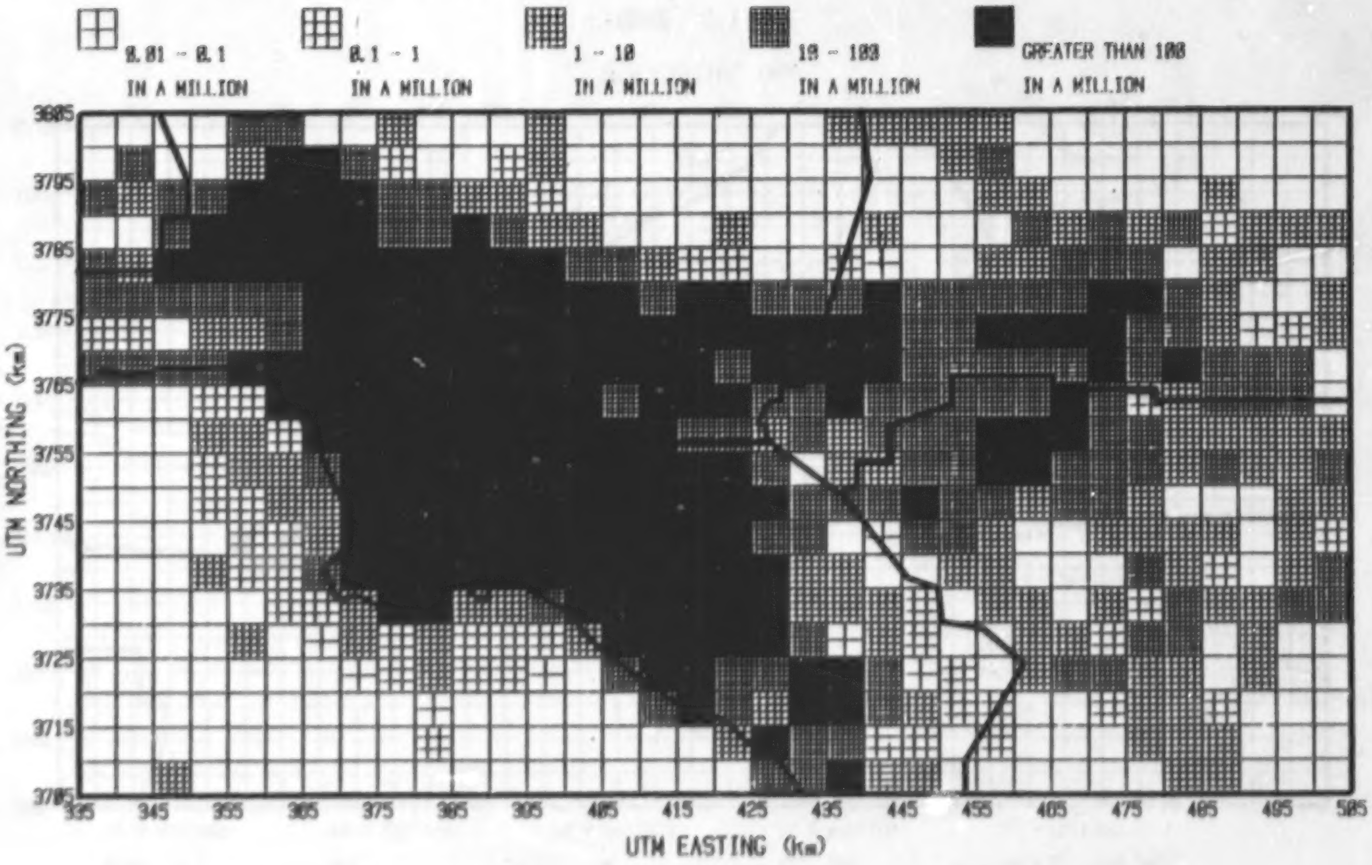

0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-2

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT BENZENE IN THE SOUTH COAST AIR BASIN

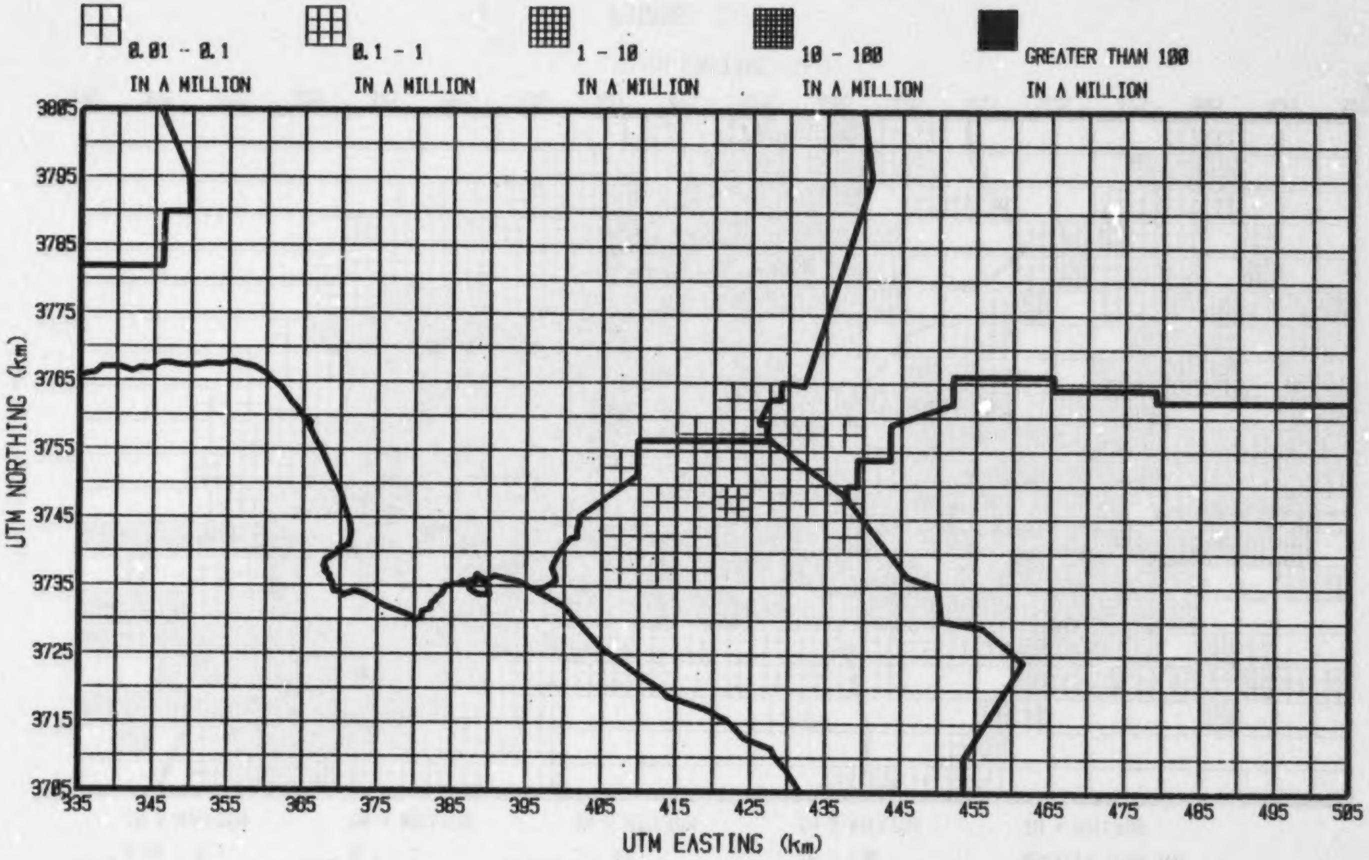

0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-3

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT BERYLLIUM IN THE SOUTH COAST AIR BASIN

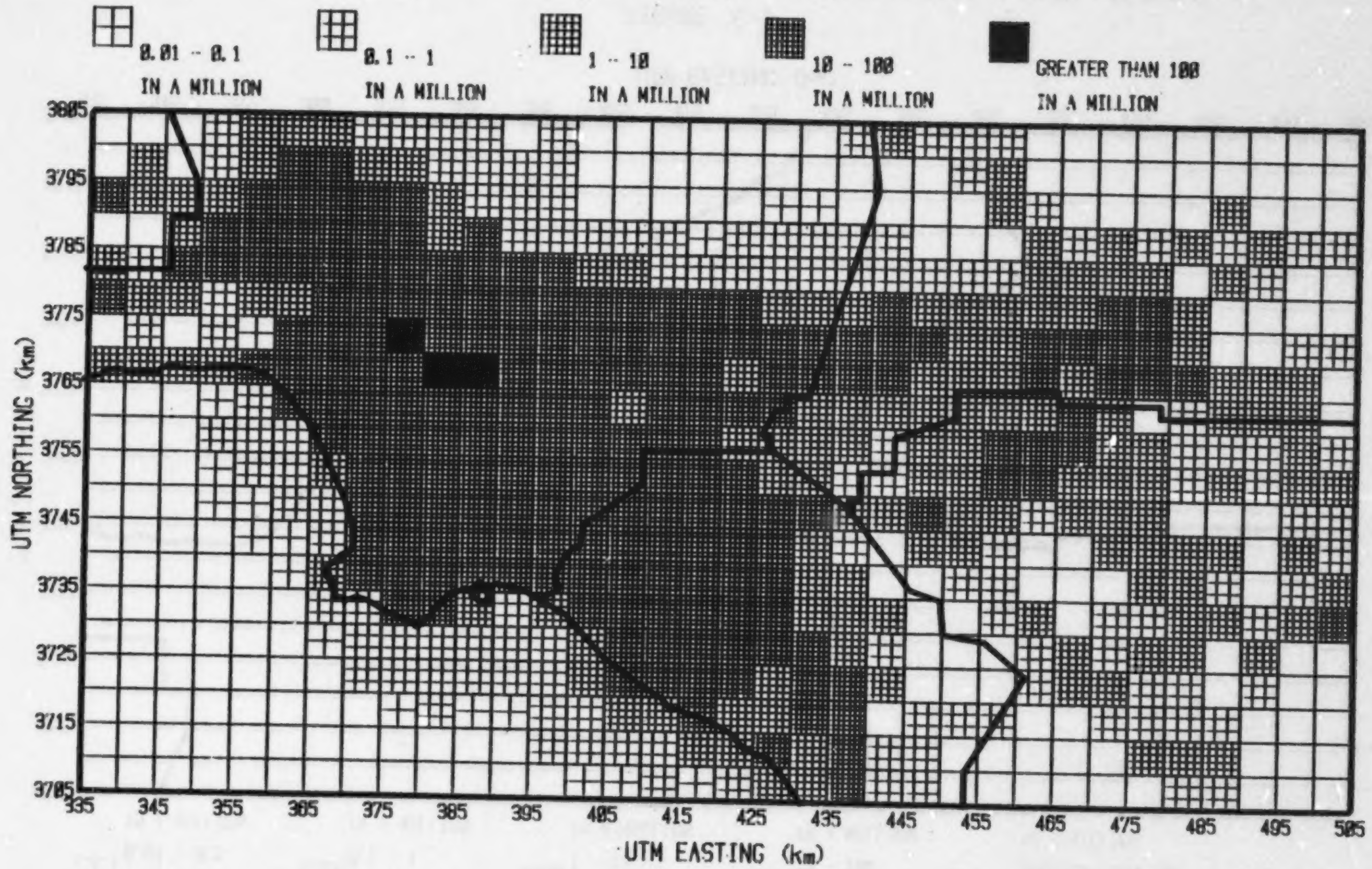

0.01 – 0.1 IN A MILLION
0.1 – 1 IN A MILLION
1 – 10 IN A MILLION
10 – 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-4

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT CADMIUM IN THE SOUTH COAST AIR BASIN

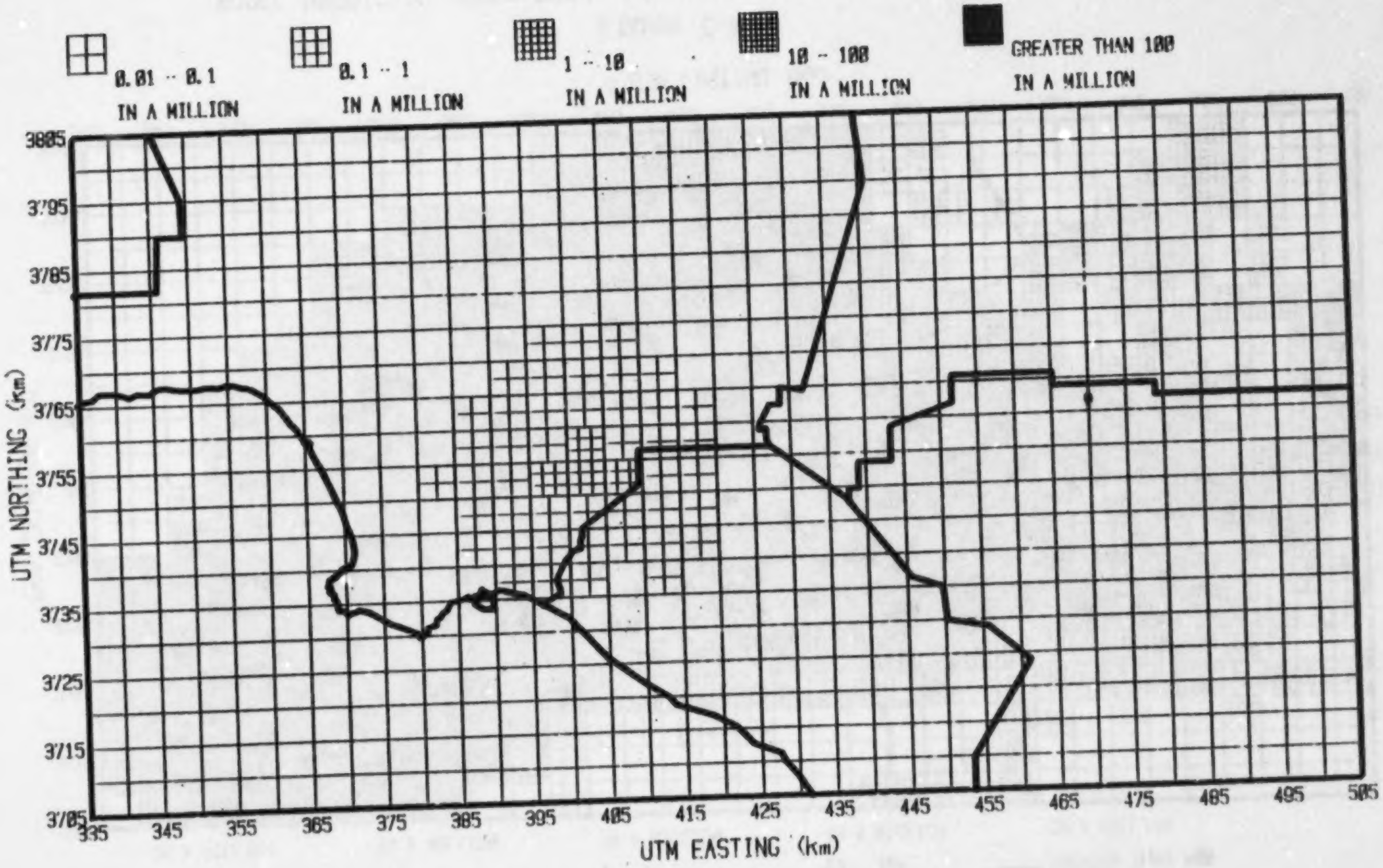
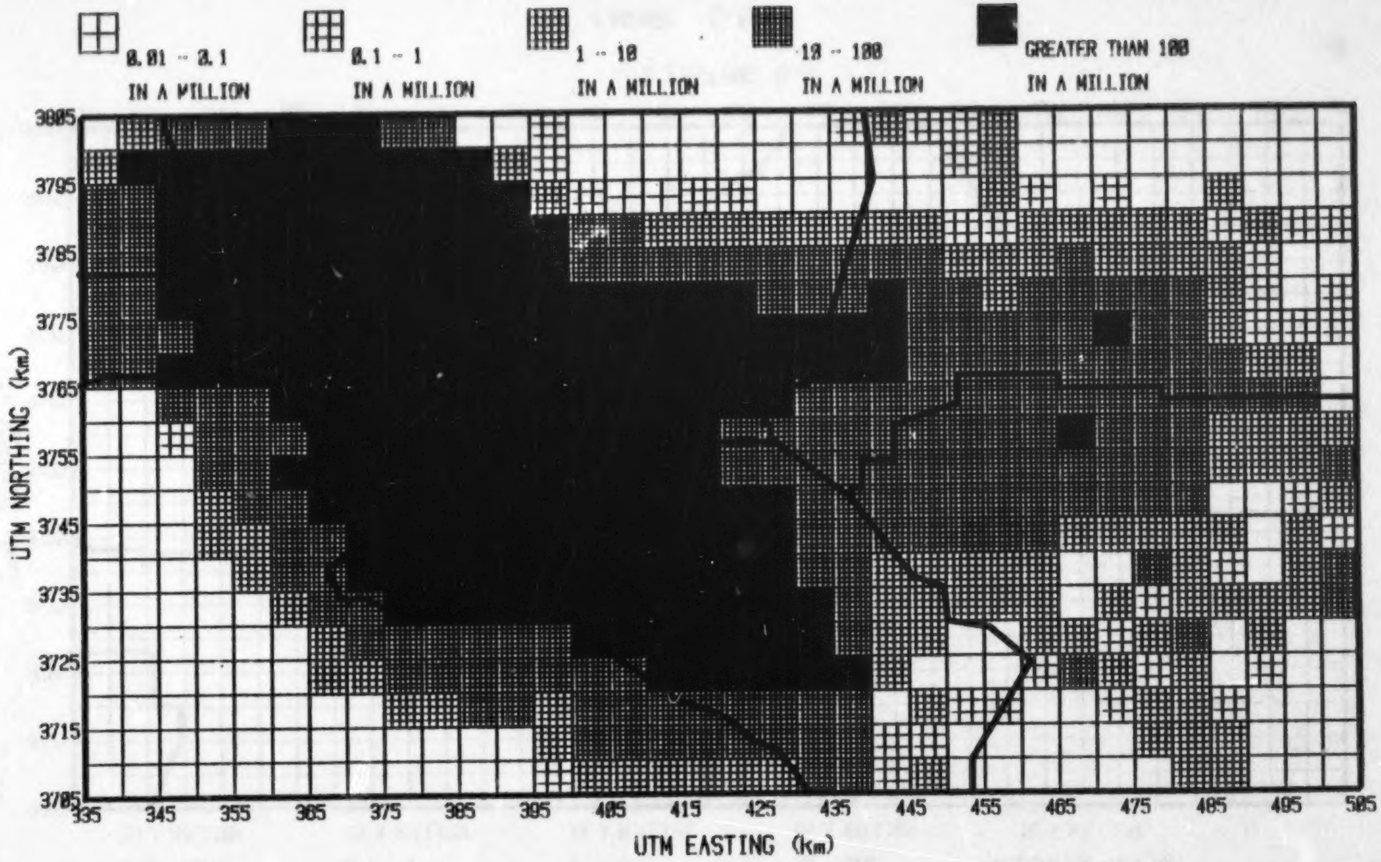

▦ 0.01 - 0.1 IN A MILLION
▦ 0.1 - 1 IN A MILLION
▦ 1 - 10 IN A MILLION
▦ 10 - 100 IN A MILLION
■ GREATER THAN 100 IN A MILLION
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (Km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE C-5

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO CARBON TETRACHLORIDE IN THE SOUTH COAST AIR BASIN



⊞ 0.01 - 0.1 IN A MILLION
▦ 0.1 - 1 IN A MILLION
▦ 1 - 10 IN A MILLION
▩ 10 - 100 IN A MILLION
■ GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-6

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT CHROMIUM (VI) IN THE SOUTH COAST AIR BASIN

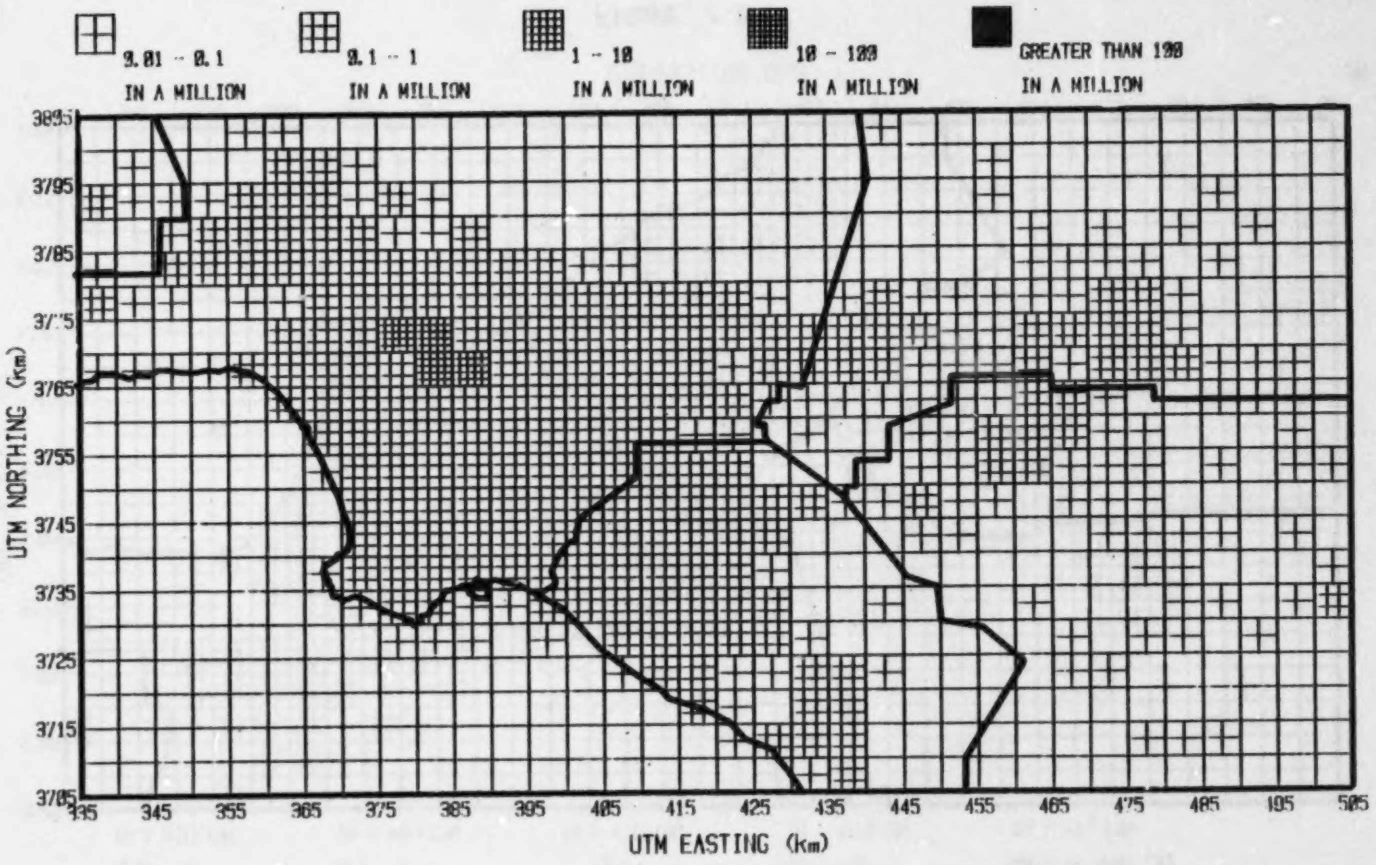
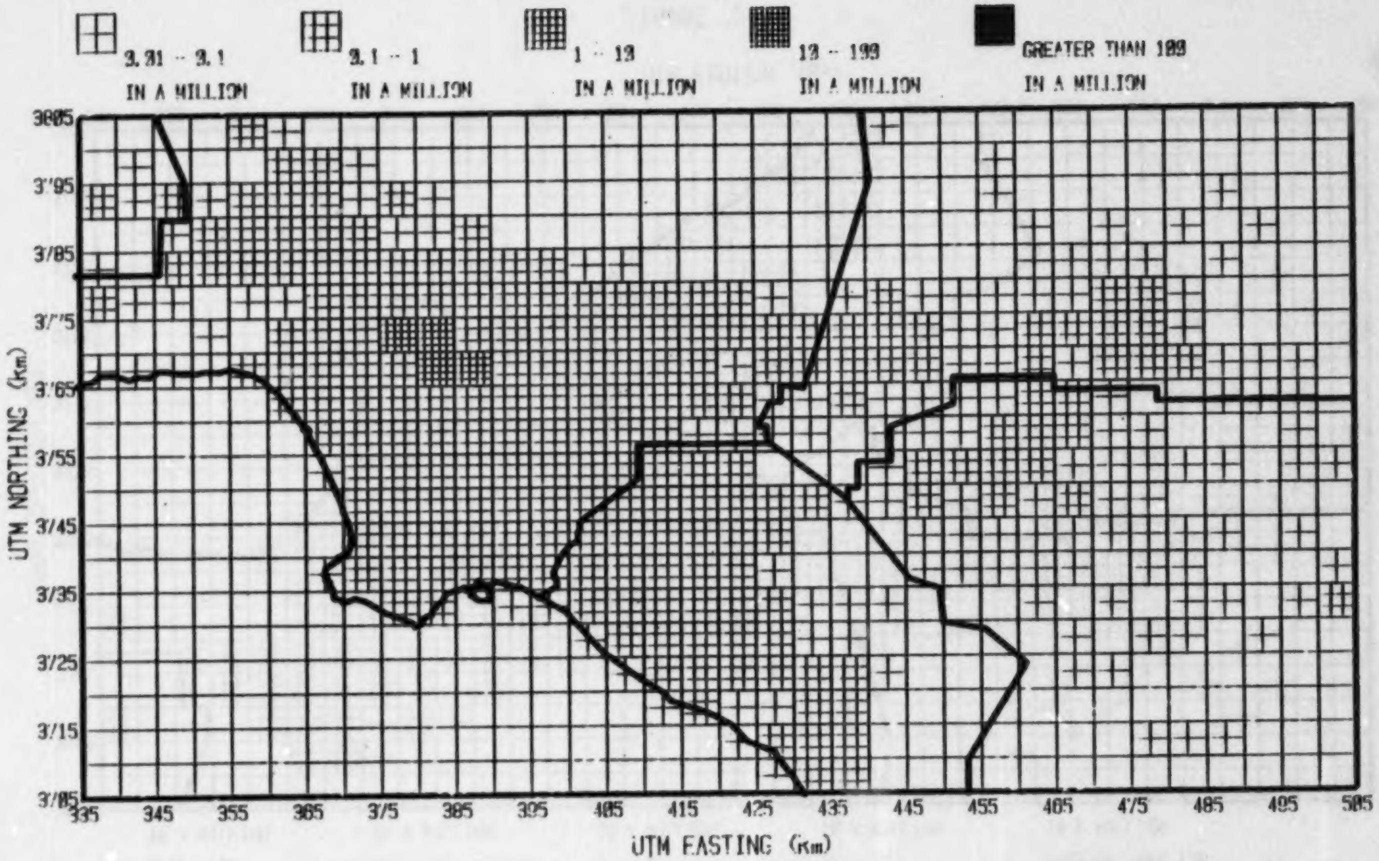

0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE C-7

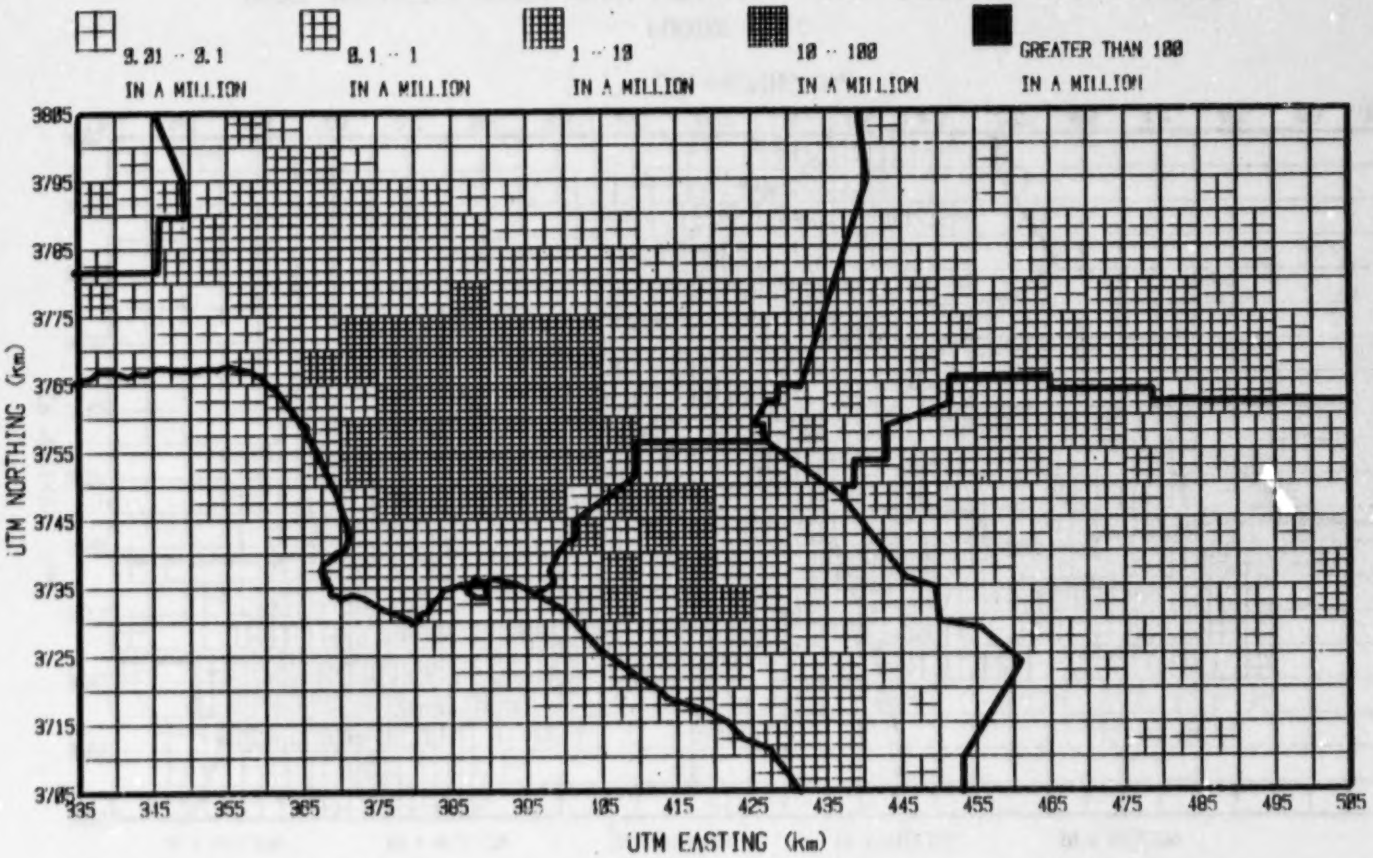
MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO ETHYLENE DIBROMIDE IN THE SOUTH COAST AIR BASIN



0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (Km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE C-8

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO ETHYLENE DICHLORIDE IN THE SOUTH COAST AIR BASIN


0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
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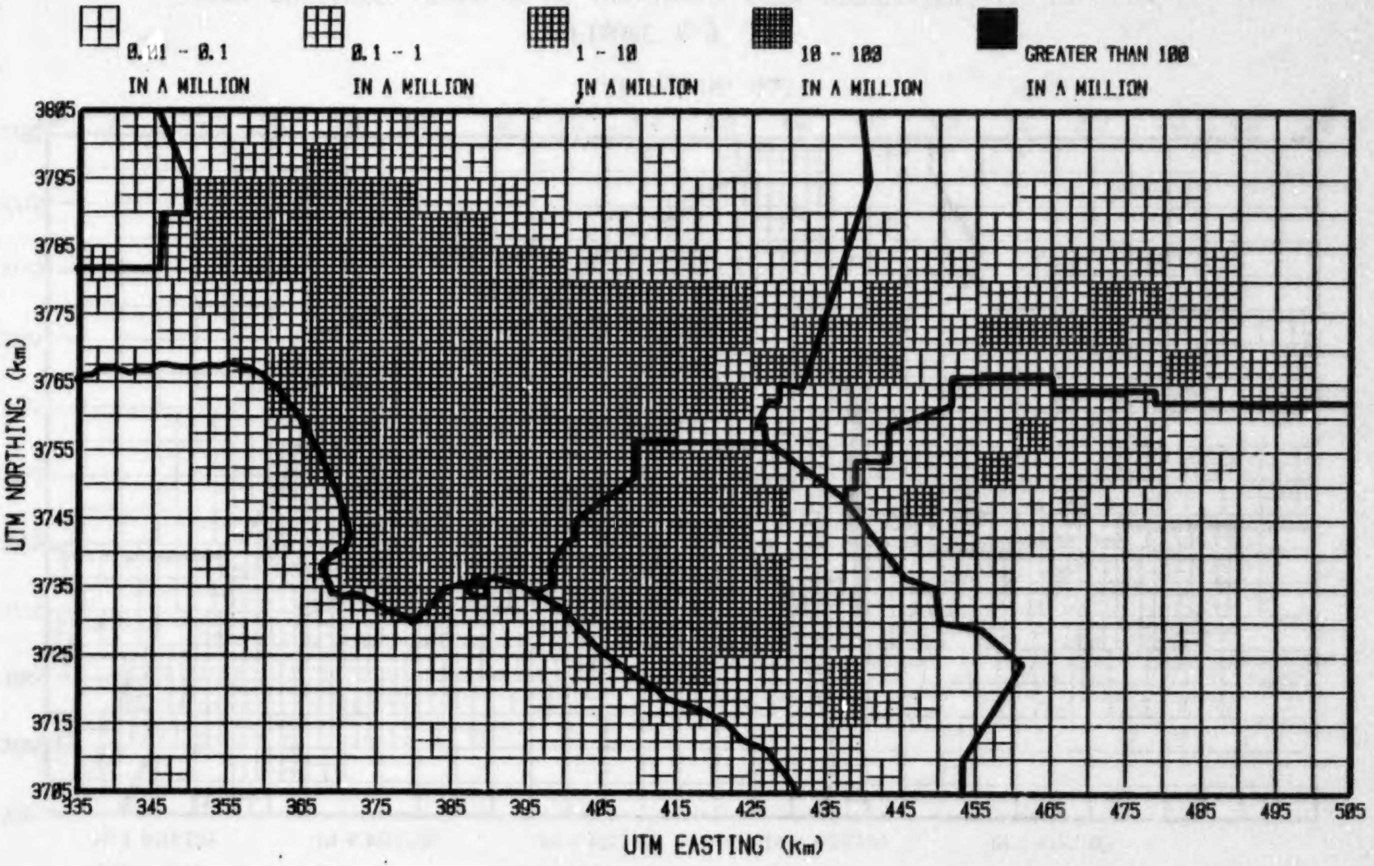
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE C-9

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO AMBIENT NICKEL IN THE SOUTH COAST AIR BASIN


0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FUGURE C-10

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO PERCHLOROETHYLENE IN THE SOUTH COAST AIR BASIN

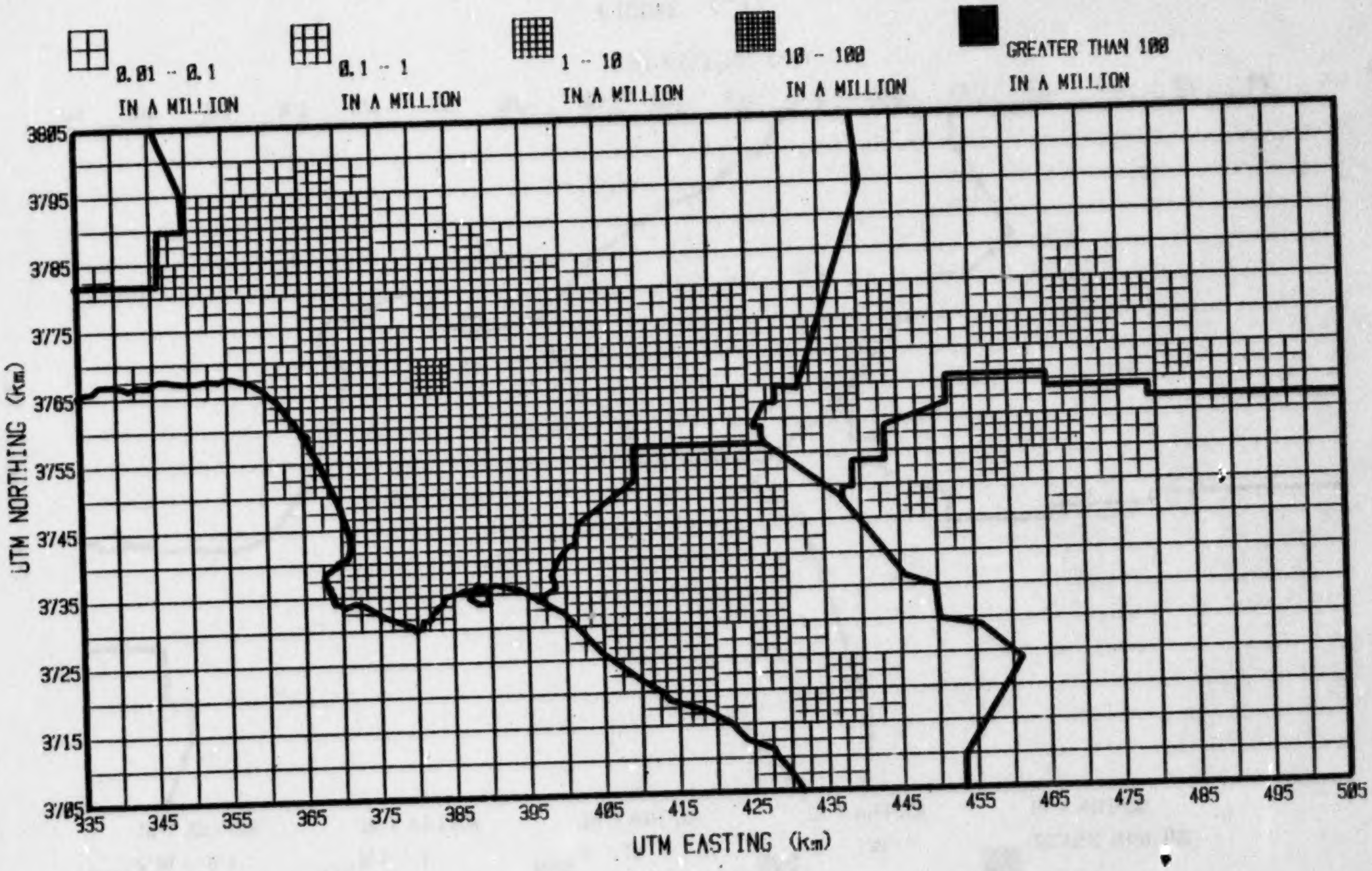
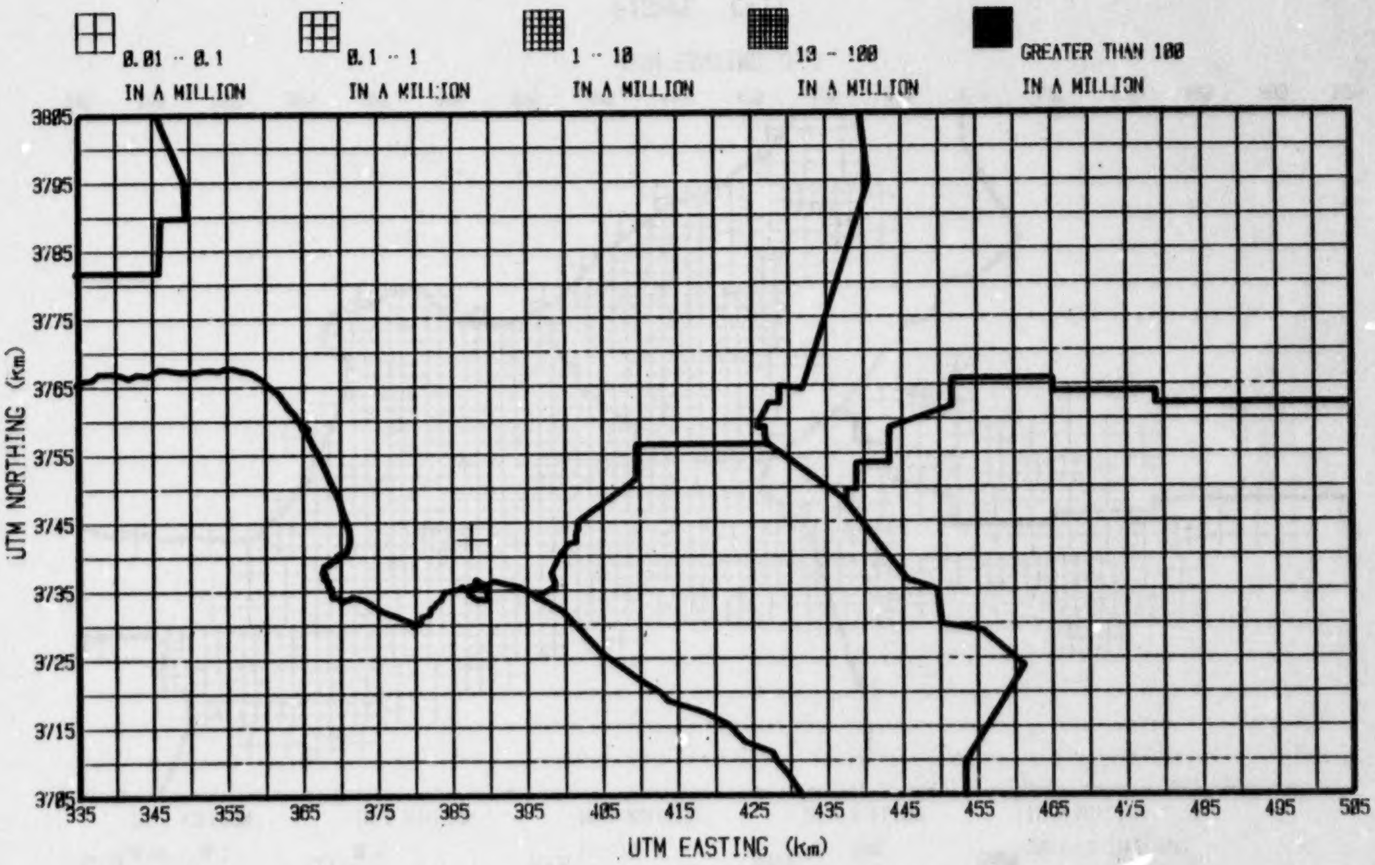

0.01 - 0.1 IN A MILLION
0.1 - 1 IN A MILLION
1 - 10 IN A MILLION
10 - 100 IN A MILLION
GREATER THAN 100 IN A MILLION
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE C-11

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO TRICHLOROETHYLENE IN THE SOUTH COAST AIR BASIN



⊞ 0.01 - 0.1 IN A MILLION
▦ 0.1 - 1 IN A MILLION
▩ 1 - 10 IN A MILLION
▩ 10 - 100 IN A MILLION
■ GREATER THAN 100 IN A MILLION
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-12

MODEL PREDICTED UPPER-BOUND INDIVIDUAL RISK ASSOCIATED WITH LIFETIME EXPOSURE TO VINYL CHLORIDE IN THE SOUTH COAST AIR BASIN

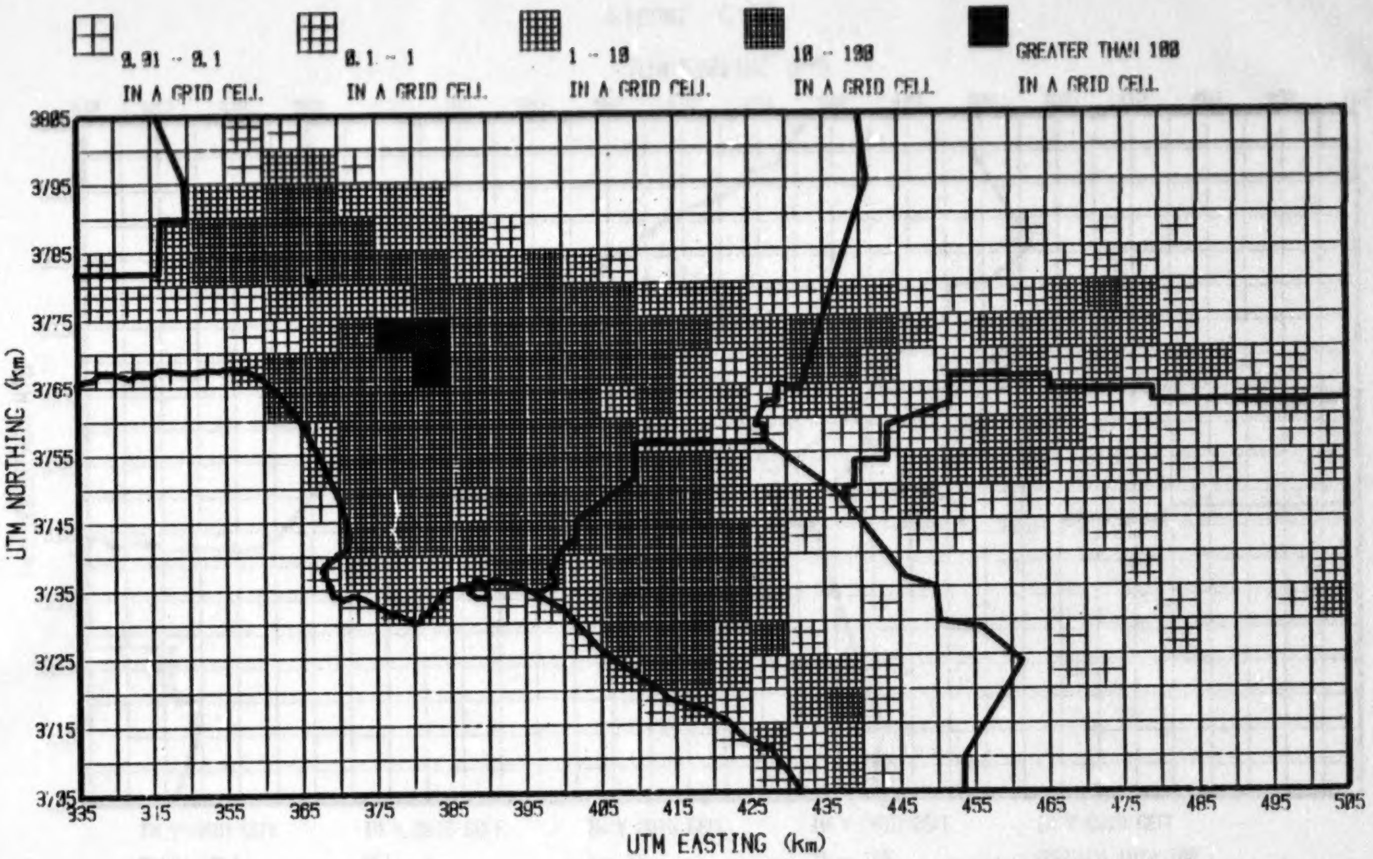
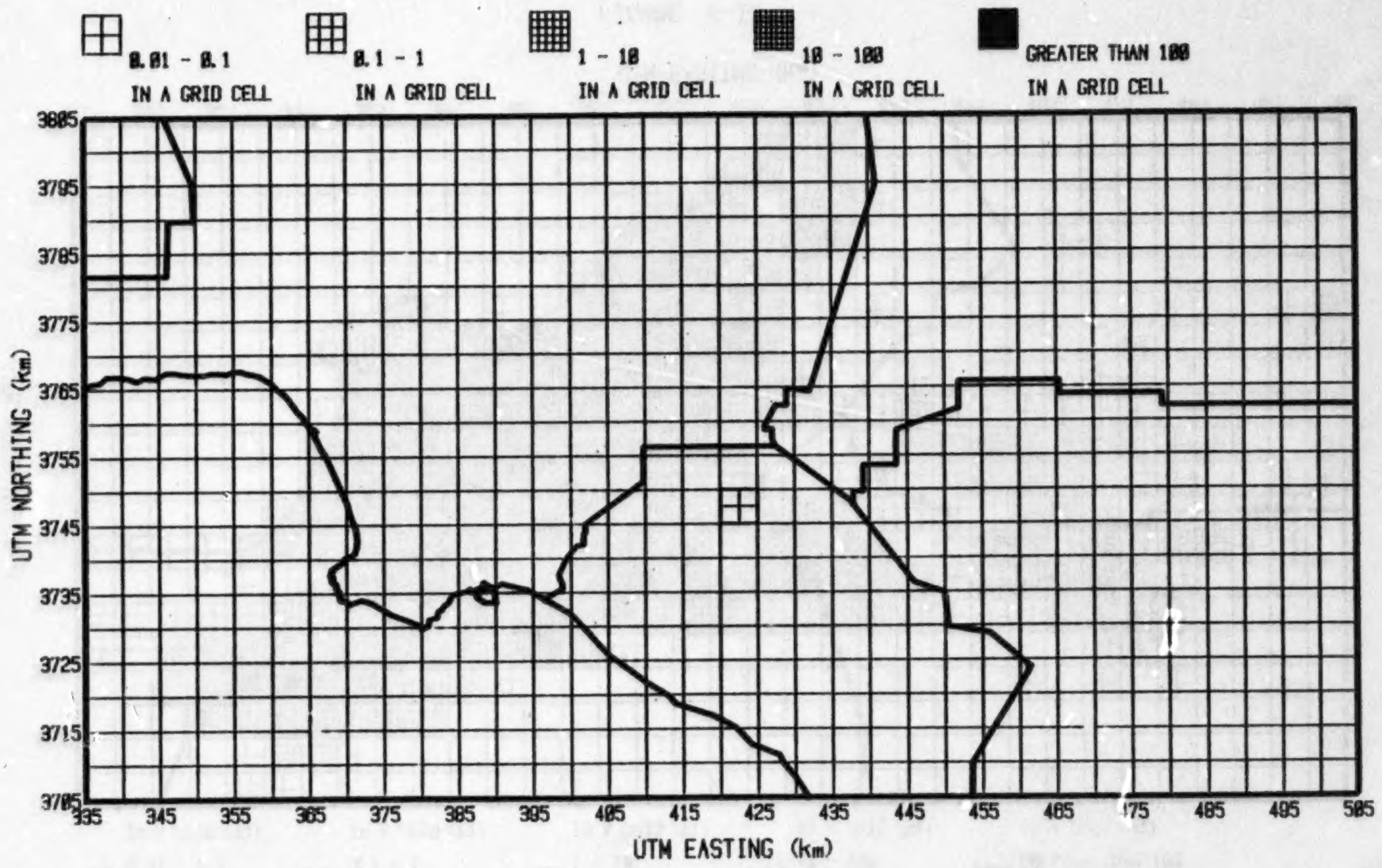

0.01 - 0.1 IN A GRID CELL.
0.1 - 1 IN A GRID CELL.
1 - 10 IN A GRID CELL.
10 - 100 IN A GRID CELL.
GREATER THAN 100 IN A GRID CELL.
UTM NORTHING (Km)
3805
3/95
3/85
3/75
3/65
3/55
3/45
3/35
3/25
3/15
3/05
335
3/5
355
365
3/5
385
395
405
415
425
435
445
455
465
4/5
485
495
505
UTM EASTING (Km)

FIGURE C-13

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO BENZENE IN THE SOUTH COAST AIR BASIN



0.01 - 0.1
IN A GRID CELL
0.1 - 1
IN A GRID CELL
1 - 10
IN A GRID CELL
10 - 100
IN A GRID CELL
GREATER THAN 100
IN A GRID CELL
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE C-14

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO BERYLLIUM IN THE SOUTH COAST AIR BASIN

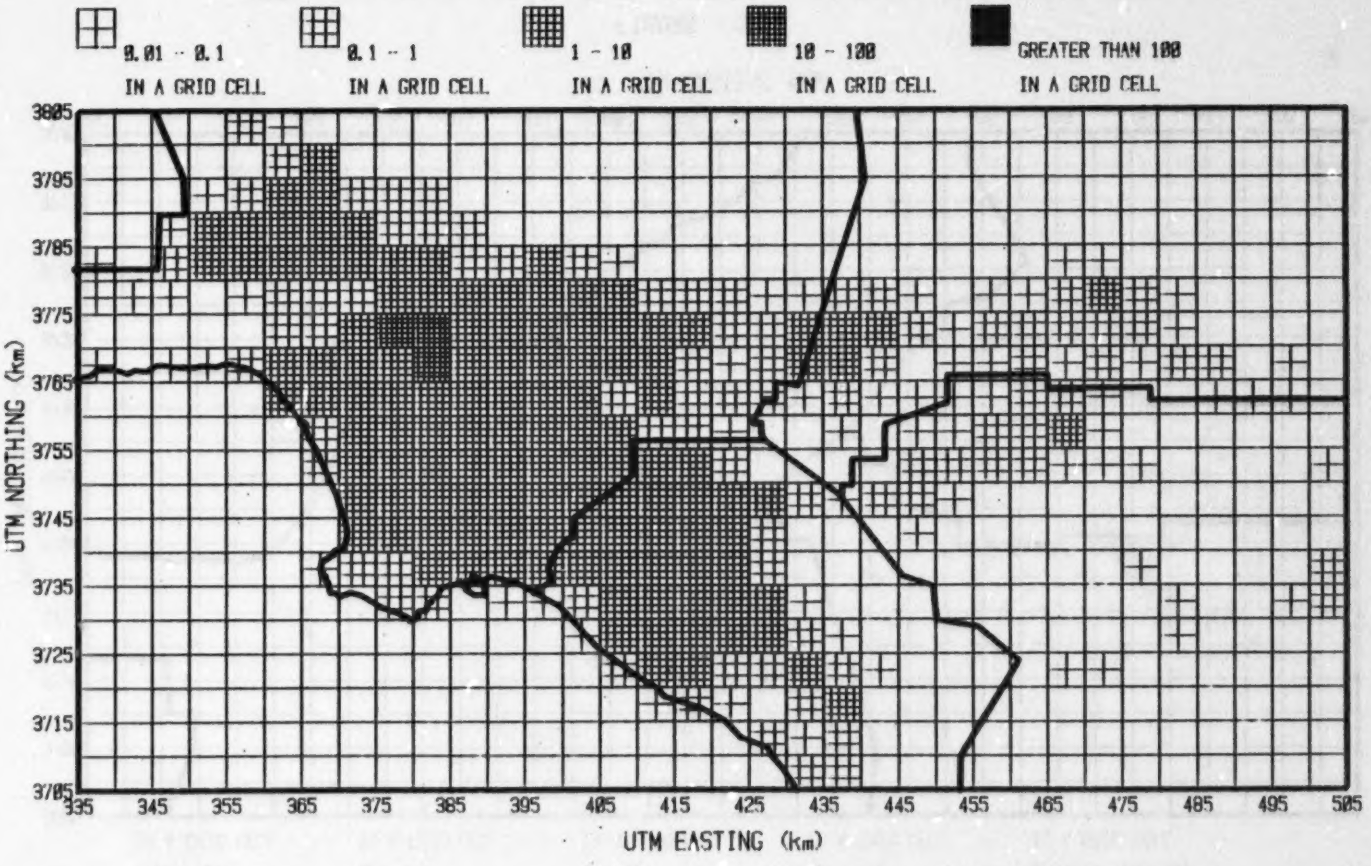
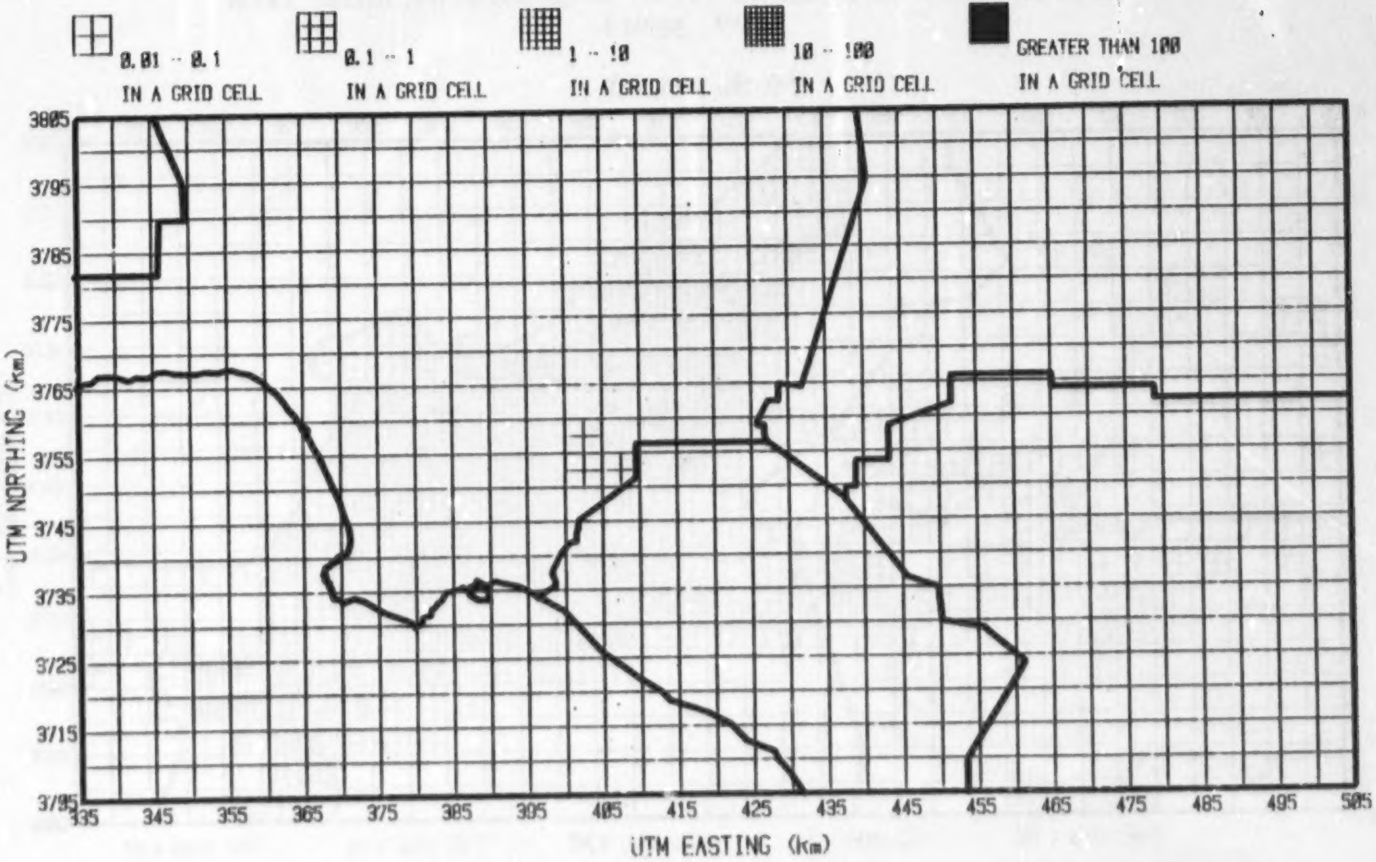

0.01 - 0.1 IN A GRID CELL
0.1 - 1 IN A GRID CELL
1 - 10 IN A GRID CELL
10 - 100 IN A GRID CELL
GREATER THAN 100 IN A GRID CELL
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM NORTHING (km)
UTM EASTING (km)

FIGURE C-15

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO CADMIUM IN THE SOUTH COAST AIR BASIN



0.01 - 0.1
IN A GRID CELL
0.1 - 1
IN A GRID CELL
1 - 10
IN A GRID CELL
10 - 100
IN A GRID CELL
GREATER THAN 100
IN A GRID CELL
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-16

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO CARBON TETRACHLORIDE IN THE SOUTH COAST AIR BASIN

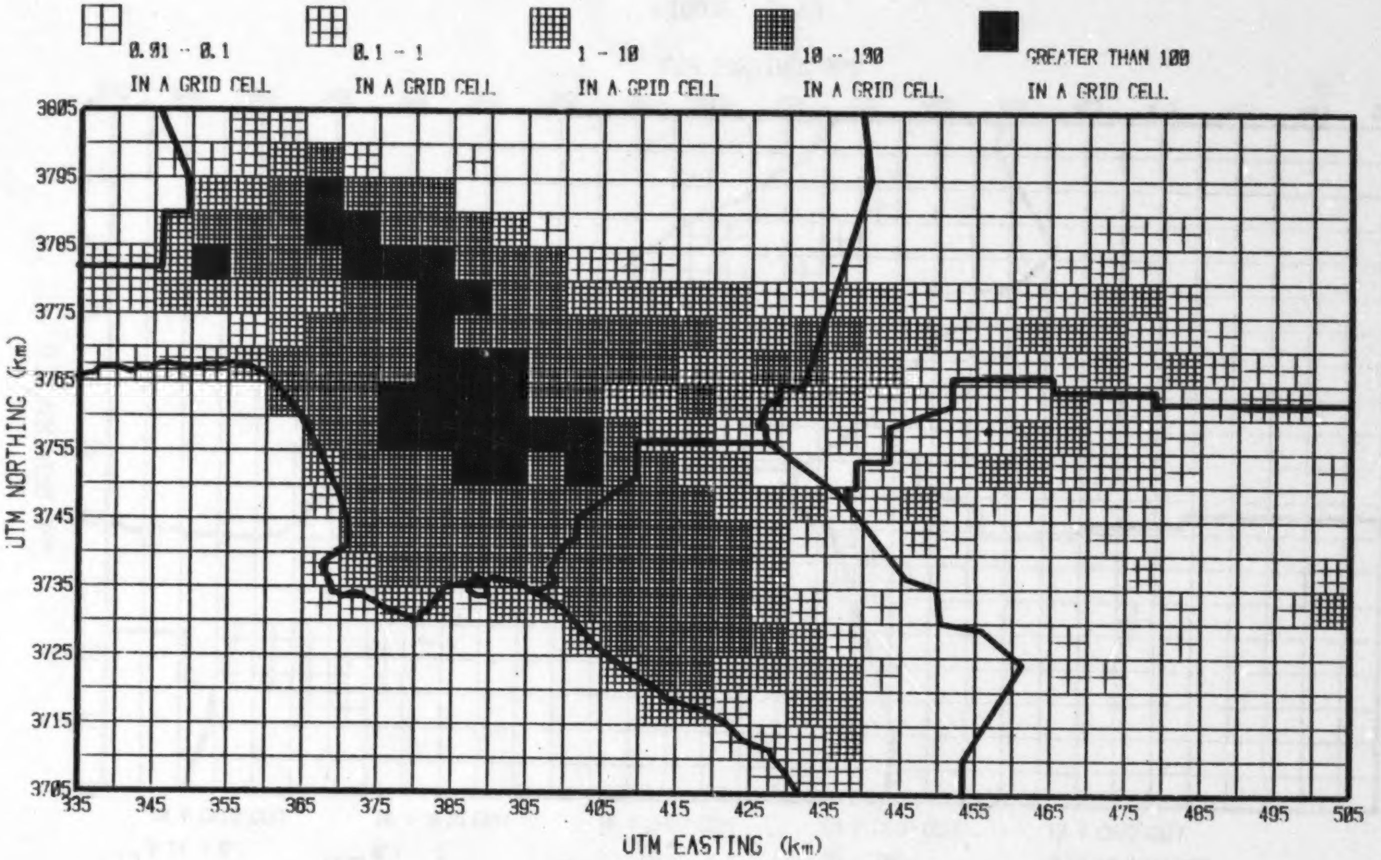

0.01 – 0.1 IN A GRID CELL
0.1 – 1 IN A GRID CELL
1 – 10 IN A GRID CELL
10 – 100 IN A GRID CELL
GREATER THAN 100 IN A GRID CELL
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE C-17

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO CHROMIUM (VI) IN THE SOUTH COAST AIR BASIN

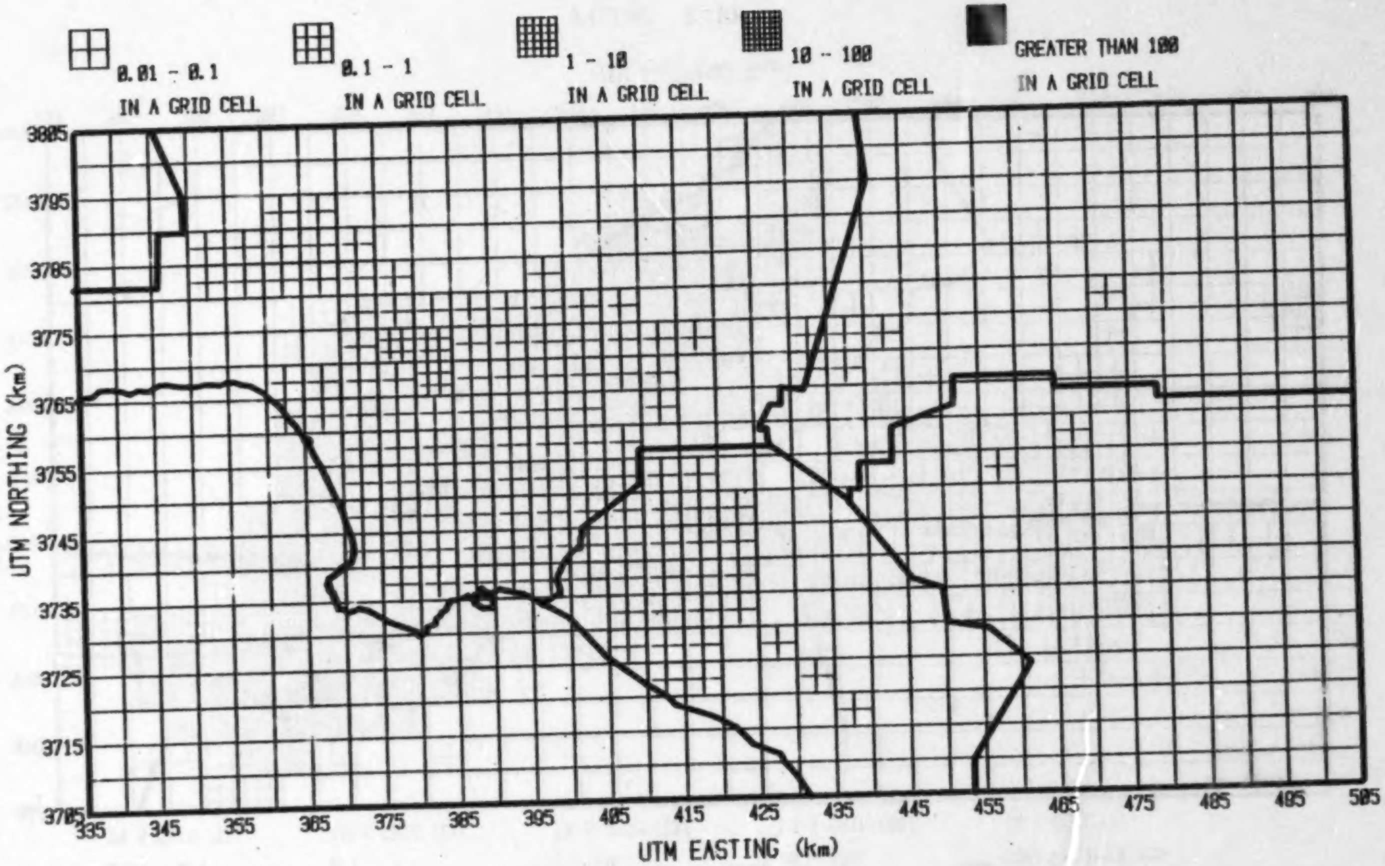

0.01 - 0.1 IN A GRID CELL
0.1 - 1 IN A GRID CELL
1 - 10 IN A GRID CELL
10 - 100 IN A GRID CELL
GREATER THAN 100 IN A GRID CELL
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE C-18

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO ETHYLENE DIBROMIDE IN THE SOUTH COAST AIR BASIN

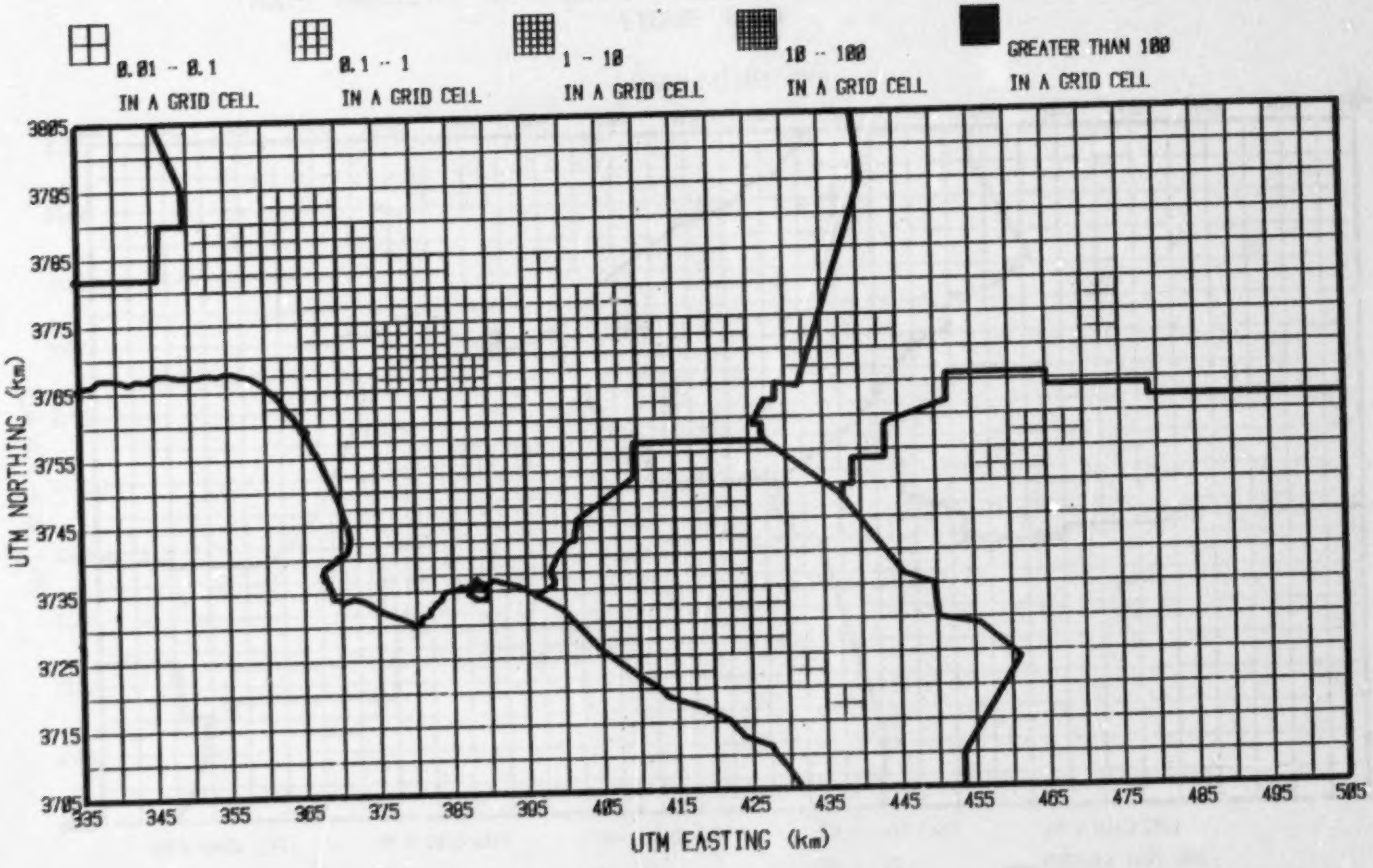

⊞ 0.01 - 0.1 IN A GRID CELL
▦ 0.1 - 1 IN A GRID CELL
▩ 1 - 10 IN A GRID CELL
▩ 10 - 100 IN A GRID CELL
■ GREATER THAN 100 IN A GRID CELL
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
UTM EASTING (km)
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505

FIGURE C-19

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO ETHYLENE DICHLORIDE IN THE SOUTH COAST AIR BASIN

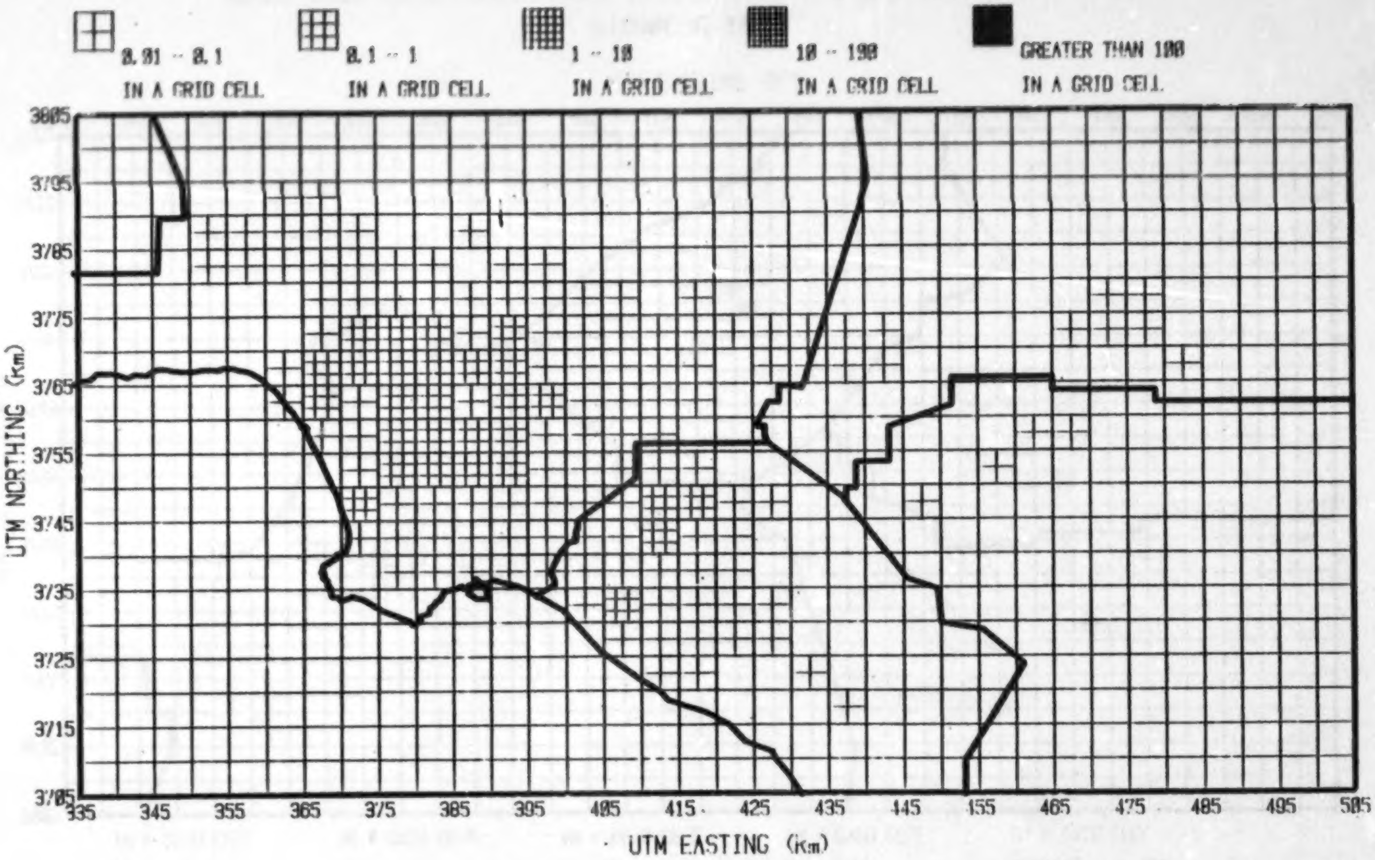

0.01 - 0.1 IN A GRID CELL
0.1 - 1 IN A GRID CELL
1 - 10 IN A GRID CELL
10 - 100 IN A GRID CELL
GREATER THAN 100 IN A GRID CELL
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE C-20

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO NICKEL IN THE SOUTH COAST AIR BASIN

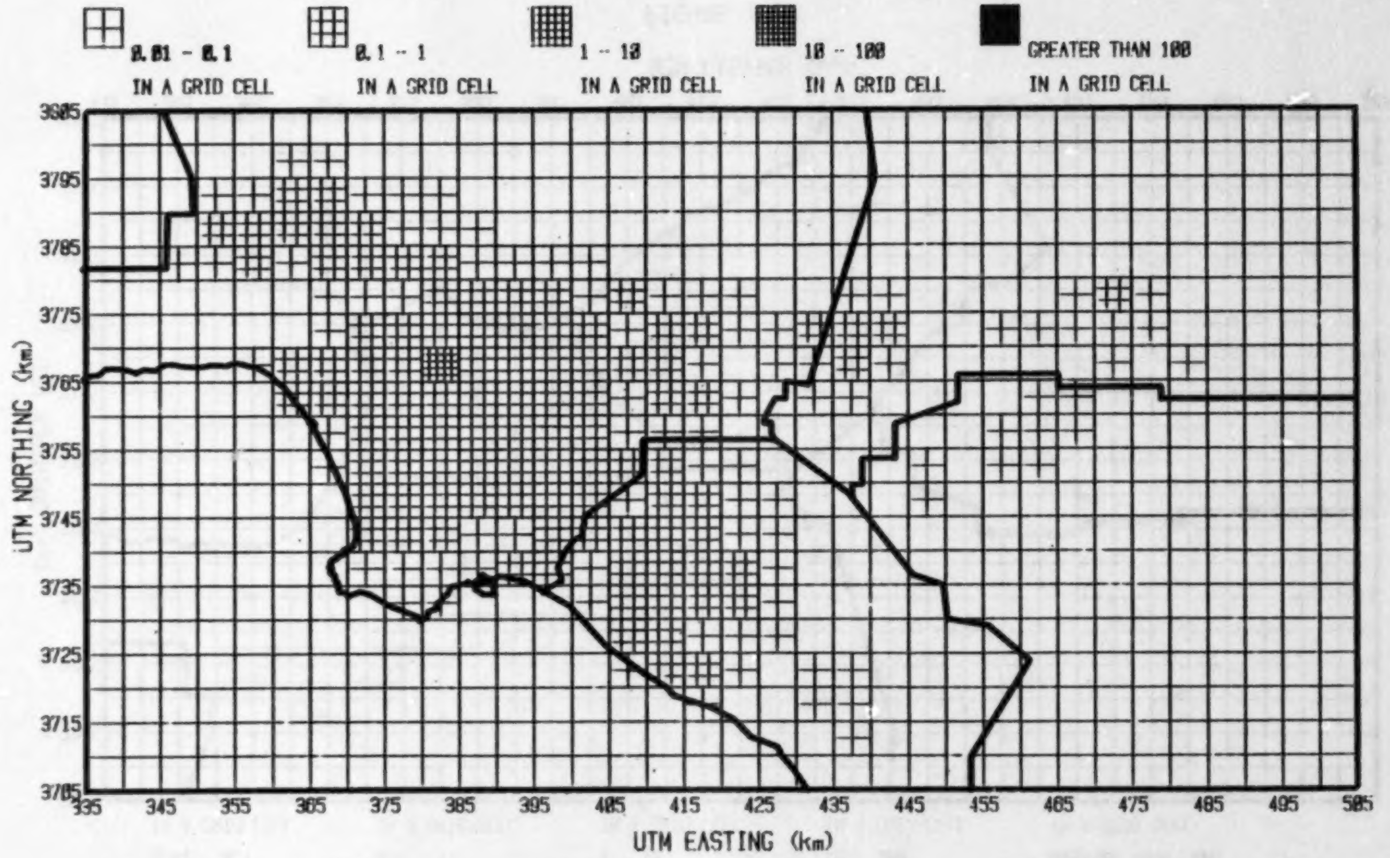
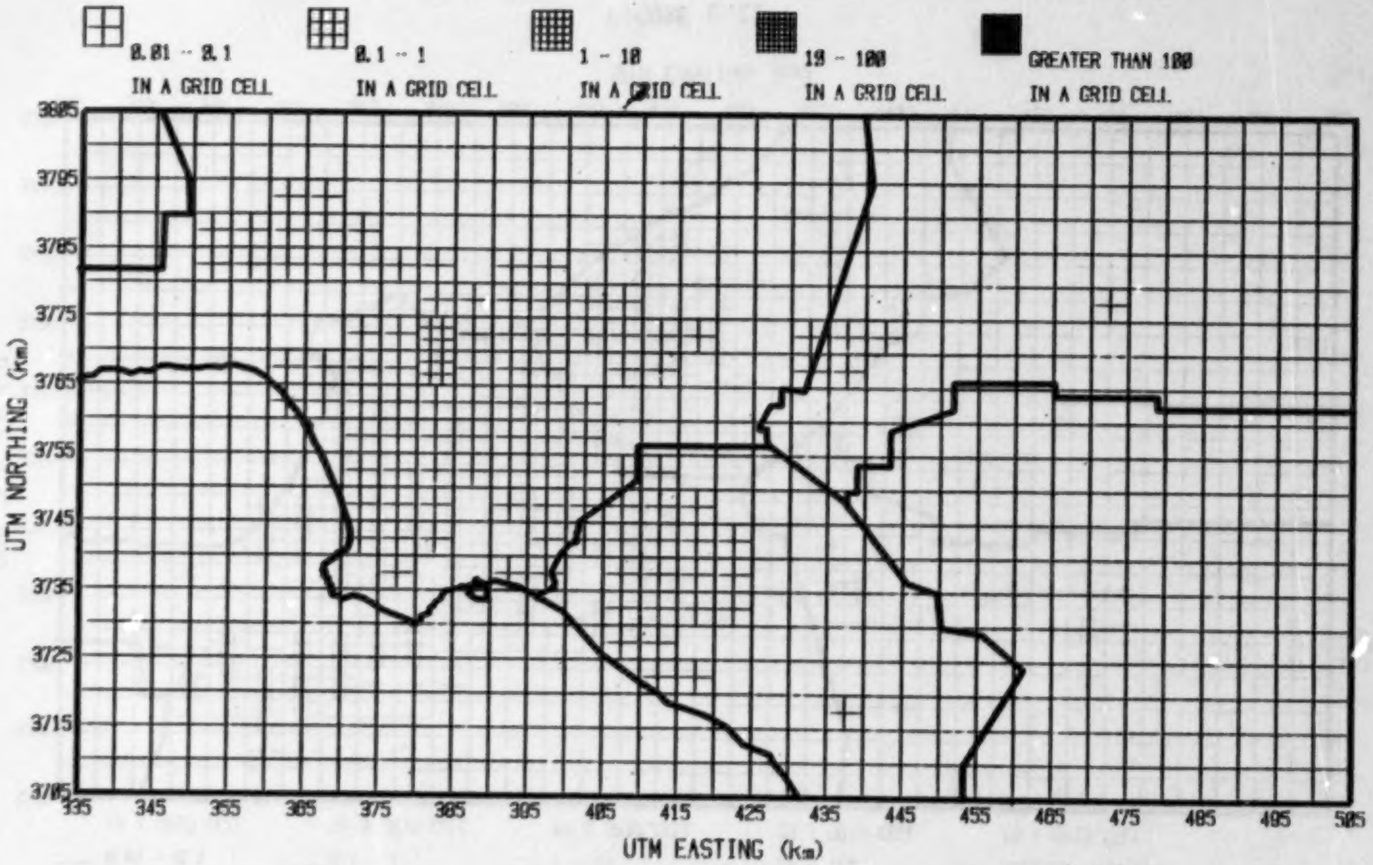

0.01 - 0.1 IN A GRID CELL
0.1 - 1 IN A GRID CELL
1 - 10 IN A GRID CELL
10 - 100 IN A GRID CELL
GREATER THAN 100 IN A GRID CELL
UTM NORTHING (km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
365
375
385
395
405
415
425
435
445
455
465
475
485
495
505
UTM EASTING (km)

FIGURE C-21

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO PERCHLOROETHYLENE IN THE SOUTH COAST AIR BASIN


0.01 - 0.1
IN A GRID CELL
0.1 - 1
IN A GRID CELL
1 - 10
IN A GRID CELL
10 - 100
IN A GRID CELL
GREATER THAN 100
IN A GRID CELL
UTM NORTHING (Km)
3805
3795
3785
3775
3765
3755
3745
3735
3725
3715
3705
335
345
355
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375
385
395
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415
425
435
445
455
465
475
485
495
505
UTM EASTING (Km)

FIGURE C-22

MODEL PREDICTED UPPER-BOUND EXCESS CANCER CASES ASSOCIATED WITH LIFETIME EXPOSURE TO TRICHLOROETHYLENE IN THE SOUTH COAST AIR BASIN